Final Program

Fifteenth International Symposium on

Mathematical Theory of Networks and Systems

University of Notre Dame,
South Bend, Indiana, USA
August 12-16, 2002.

www.nd.edu/~mtns/

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WELCOME TO MTNS 2002

On behalf of the Organizing Committee of MTNS 2002 I welcome you to the 15th edition of MTNS, the International Symposium on the Mathematical Theory of Networks and Systems.

The symposium is organized every two years and traditionally covers areas involving a wide range of research directions in mathematical systems, networks and control theory. Mathematical methods which play a role in the areas mentioned above stem from a broad range of fields of pure and applied mathematics, including ordinary and partial differential equations, real and complex analysis, numerical analysis, probability theory and stochastic analysis, operator theory, linear and commutative algebra as well as algebraic and differential geometry. There are a wide range of applications ranging from problems in biology, communications and mathematical finance to problems in chemical engineering, aerospace engineering and robotics. One of the special features of MTNS 2002 will be 5 Mini-symposia, each consisting of a whole series of sessions. The Mini-sypomposia reflect areas where systems and control theory play a significant role.

MTNS 2002 features a total of 20 plenary and semi-plenary talks by some of the leading researchers in the area of systems and control theory. There will also be 90 sessions lasting 2 hours each. Members of the International Program Committee and Members from the Steering Committee were actively involved in the reviewing process and in the organization of sessions. I would like to express my sincere thank to all the members of these committees. I would also like to thank the Staff of the Department of Mathematics and the Center for Continuing Education at Notre Dame for their great help in the organization. A special thanks goes to David Gilliam, who worked countless hours, day and night, to make the submission of abstracts and papers and the completion of the conference proceedings a reality.

MTNS 2002 received generous support from the National Science Foundation, The Institute for Mathematics and its Applications (IMA) in Minnesota and from various departments and colleges at the University of Notre Dame. This support made it possible that many young researchers received travel support to attend MTNS 2002.

We hope you will find the 15th edition of MTNS interesting and rewarding.

Joachim Rosenthal
MTNS 2002 Symposium Chair

MTNS HISTORY

The fourteen previous MTNS meetings were held in:

1973 : College Park, Maryland, USA,

1975 : Montreal,Canada,

1977 : Lubbock, Texas, USA,

1979 : Delft, Netherlands,

1981 : Santa Monica, California, USA,

1983 : Beer Sheva, Israel,

1985 : Stockholm, Sweden,

1987 : Phoenix, Arizona, USA,

1989 : Amsterdam, Netherlands,

1991 : Kobe, Japan,

1993 : Regensburg, Germany,

1996 : St. Louis, Missouri, USA,

1998 : Padova, Italy,

2000 : Perpignan, France.

Financial Support was received for MTNS 2002 from:

National Science Foundation (NSF)
Institute for Mathematics and its Applications (IMA)
Center for Applied Mathematics, Notre Dame
Provost Office of University of Notre Dame
College of Science, University of Notre Dame
Graduate School at University of Notre Dame

Special Events at MTNS 2002

- **Minisymposium on Biological Systems:**
  Organizers: Mark Alber and Raimund Ober.
  Sessions: TUA2: Patterns in Biology
  TUM2: Immunology 1: Introduction and Microscopy
  TUP2: Immunology 2: Microscopy and Biophysics
  WA1: Immunology 3: Structure and Kinetics
  WM1: Immunology 4: Diffusion and Modelling
  WP1: Immunology 5: Cellular Aspects
  THA1: Complex Networks and Biological Applications 1
  THM1: Complex Networks and Biological Applications 2
  THP1: Complex Networks and Biological Applications 3
  FA1: Genetic Networks

- **Minisymposium on Communication Systems:**
  Organizers: David Forney and Brian Marcus.
  Sessions: MA1: Minicourse on "Capacity of Multidimensional Codes"
  MM1: Capacity of Multi-Dimensional Codes Part II
  MP1: The Interaction of Control, Information and Communication
  TUA1: Design and Analysis of Block Codes, Part I
  TUM1: Design and Analysis of Block Codes, Part II
  TUP1: Convolutional Codes
  WA2: Computer Networks
  WM2: Control and Communications
  WP2: Cryptography

- **Minisymposium on Control and Computation:**
  Organizers: Paul van Dooren, Uwe Helmke and Volker Mehrmann
  Sessions: WA4: Model Reduction
  WM4: Control and Computation
  WP4: Large-Scale Computations in Control
  THA4: Fully Nonlinear, Three-Dimensional, Surface Water Waves in Arbitrary Depth
  THM4: Robust Control and Linear Matrix Inequalities
  THP4: Computational Methods for Structured Matrices and Applications
  FA4: Stability and Numerics
  FM4: Nonlinear Surface Water Waves: Theory, Computation and Experiment

- **Minisymposium on Financial Systems:**
  Organizers: Hans Schumacher and Michael Taksar.
  Sessions: THA3: Systems and Control Theory in Finance and Insurance 1
  THM3: Systems and Control Theory in Finance and Insurance 2

- **Minisymposium on Multidimensional Systems:**
  Organizers: Krzysztof Galkowski, Eric Rogers and Victor Vinnikov.
  Sessions: TUA3: Minicourse A: Multidimensional Systems
  TUM3: Multidimensional Systems 1
  TUP3: Multidimensional Systems 2
  WA3: Minicourse B: Multidimensional Systems
  WM3: Multidimensional Systems 3
  WP3: Multidimensional Systems 4
  THA5: Multidimensional Systems 5

- **Workshop on Open Problems in Systems Theory:**
  Organizer: Vincent Blondel
  Time: Monday and Tuesday, August 12, 13 from 20:00–22:00 in Room 102 De Bartolo Hall.

- **Panel Discussion on "Future Directions of Research and Teaching on Mathematical Control and Systems Theory":**
  Organizer: Biswa Datta
  Time: Wednesday Evening August 14, from 20:00–22:00 in Room 102 De Bartolo Hall.

Plenary Speakers:

Anthony Bloch (University of Michigan),
William Helton (University of California),
Bruce Hajek (University of Illinois),
Gilbert Strang (MIT),
Eduardo Sontag (Rutgers University).

Special Topic Invited Speaker:

Albert-Laszlo Barabasi (University of Notre Dame),
Roger Brockett (Harvard University),
Raffaello D'Andrea (Cornell University),
Matthias Heinkenschloss (Rice University),
Knut Hueper (University of Wuerzburg),
Karl Kunisch (Graz University),
Hans-Andrea Loeliger (ETH),
Robert J. McEliece (Cal Tech),
Wolfgang Runggaldier, (University of Padova),
Arjan van der Schaft (University of Twente),
Olof Staffans (Abo Akademi University),
Allen Tannenbaum (Georgia Tech),
Sjoerd Verduyn Lunel (University of Leiden),
Jan Willems (University of Groningen),
Jeffrey Wood (University of Southampton).

General Information

Registration Desk: The Registration desk is located in McKenna Hall, also called Center for Continuing Education (CCE). It will be open Sunday afternoon August 11, and staff will be available throughout the conference week during business hours.

Shuttle Bus: There will be continuous loops from the two conference hotels (Comfort Suites and Inn at Saint Mary's) to the conference center (CCE) housed in McKenna Hall during the times:

Sunday,	August 11	noon - 9:30 pm
Monday,	August 12	7 am - 10:30 pm
Tuesday,	August 13	7 am - 10:30 pm
Wednesday,	August 14	7 am - 10:30 pm
Thursday,	August 15	7 am - 10:30 pm
Friday,	August 16	7 am - 9 pm

Computer Access: Every participant receives his own login name and his own password. It will allow her/him to access the Notre Dame computer system from a machine in De Bartolo Hall.

Recreational Activities: The registration package will include information on possibilities to use the recreational facilities at Notre Dame like e.g. the swimming pools and the golf course.

Social Events:

- Sunday 18:00-21:00: There is a Welcoming Party in the Center for Continuing Education.
- Thursday 19:00-22:00: Banquet Dinner
- Friday 18:00-20:00: Farewell Party.

Notre Dame Tourism: The University offers a regular schedule of campus tours. Call the Eck Visitors' Center at (574) 631-5726 for more information.
Next to De Bartolo Hall is the Snite Museum of Art with a good collection of Fine Art. Admission is free.

		Monday, August 12, 2002						
	Room 101	Room 102	Room 126	Room 129	Room 136/138	Room 208	Room 209	Room 210
M 8:00-8:30	Welcoming Remarks							
M 8:30-9:30	Bruce Hajek							
M 9:30-10:30	Roger Brockett	Andrea Loeliger			Sjoerd Verduyn Lunel			
Coffee Break								
M 11:00-13:00		Capacity of Multidimensional Codes 1	ControlApplications		Matrix and Operator Equations I	Positive Systems	Control of Quantum Mechanical Systems	Adaptive Control
Lunch Break								
M 14:00-16:00		Capacity of Multidimensional Codes 2	Nonlinear Systems and Control 1	Stochastic System 1	State Space Methods for Problems in Operator Theory	Output Feedback Control of Linear Systems	Optimization and Optimal Control	
Coffee Break								
M 16:30-18:30		The Interaction of Control, Information and Communication	Nonlinear Systems and Control 2	Stochastic Control and its Application	Spaces with Indefinite Metric and Inverse		Algebraic Systems Theory	Hybrid Systems and Control
Dinner								
M 20:00-22:00		Open Problems Workshop						

		Tuesday, August 13, 2002						
	Room 101	Room 102	Room 126	Room 129	Room 136/138	Room 208	Room 209	Room 210
Tu 8:00-9:00	Gilbert Strang							
Tu 9:00-10:00	Arjan van der Schaft	Robert McEliece		Jeffrey Wood				
Coffee Break								
Tu 10:30-12:30		Design and Analysis of Block Codes 1	Patterns in Biology	Minicourse Multidimensional Systems	Input-to-State Stability, Part I	Linear Systems	Quantum Engineering 1	Robust Estimation, Identification, and Detection
Lunch Break								
Tu 14:00-16:00		Design and Analysis of Block Codes 2	Immunology 1: Introduction and Microscopy	Multidimensional Systems 1		Recent Developments in Interpolation and Completion Problems	Control of Distributed Parameter Systems	Filtering and Identification
Coffee Break								
Tu 16:30-18:30		Convolutional Codes	Immunology 2: Microscopy and Biophysics	Multidimensional Systems 2	Nonlinear Systems and Control 3		Infinite Dimensional Systems	Robust and H-Infinity Control and Estimation
Dinner								
Tu 20:00-22:00		Open Problems Workshop						

Wednesday, August 14, 2002

	Room 101	Room 102	Room 126	Room 129	Room 136/138	Room 208	Room 209	Room 210
W 8:00-9:00	William Helton							
W 9:00-10:00	Jan Willems	Laszlo Barabasi			Knut Hueper			
Coffee Break								
W 10:30-12:30		Immunology 3: Structure and Kinetics	Computer Networks	Minicourse Multidimensional Systems	Model Reduction	Time-Varying Systems and Numerical Problems	Nonlinear Systems and Control 4	Discrete Event and Hybrid Systems
Lunch Break								
W 14:00-16:00		Immunology 4: Diffusion and Modelling	Control and Communications	Multidimensional Systems 3	Control and Computation	Stochastic System 2	Algebraic and Differential Geometry in Systems Theory	Hybrid Control System Analysis, Synthesis and Diagnosis
Coffee Break								
W 16:30-18:30		Immunology 5: Cellular Aspects	Cryptography	Multidimensional Systems 4	Large-Scale Computations in Control	Expressing Polynomials as Sums of Squares Together with Applications	Quantum Engineering 2	
Dinner								
W 20:00-22:00		Panel Discussion						

		Thursday, August 15, 2002						
	Room 101	Room 102	Room 126	Room 129	Room 136/138	Room 208	Room 209	Room 210
Th 8:00-9:00	Eduardo Sontag							
Th 9:00-10:00			Olof Staffans	Wolfgang Runggaldier	Matthias Heinkenschloss			
Coffee Break								
Th 10:30-12:30		Biological Networks 1	Distributed Parameter Systems: Theory Part I	Systems and Control Theory in Finance and Insurance, Part 1	Fully Nonlinear, Three-Dimensional, Surface Water Waves in Arbitrary Depth	Multidimensional Systems 5	Globally Stable Robust Visual Servoing	Matrix and Operator Equations 2
Lunch Break								
Th 14:00-16:00		Biological Networks 2	Distributed Parameter Systems: Theory Part II	Systems and Control Theory in Finance and Insurance, Part 2	Robust Control and Linear Matrix Inequalities	The Behavioral Approach to Dynamic Systems	Control and Dynamics of Mechanical Systems 1	Control and Algebra
Coffee Break								
Th 16:30-18:30		Biological Networks 3	Distributed Parameter Systems: Stabilization and Control, Part I	Stochastic Theory and its Applications	Computational Methods for Structured Matrices and Applications		Control and Dynamics of Mechanical Systems 2	New Approaches to Adaptive Control
Banquet Dinner								

		Friday, August 16, 2002						
	Room 101	Room 102	Room 126	Room 129	Room 136/138	Room 208	Room 209	Room 210
F 8:00-9:00	Anthony Bloch							
F 9:00-10:00	Raffaello D'Andrea	Allen Tannenbaum	Karl Kunisch					
Coffee Break								
F 10:30-12:30		Genetic Networks	Distributed Parameter Systems: Stabilization and Control, Part II	Stochastic Control and Estimation	Stability and Numerics	A Behavioral Approach to Systems, Control and Coding Theory	Coordinated Control of Vehicle Networks	Nonlinear Control and Applications
Lunch Break								
F 14:00-16:00		Mathematical Theory of Networks and Circuits	Distributed Parameter Systems: Applications and Computation, Part I	Operator Theoretic Methods	Nonlinear Surface Water Waves: Theory, Computation and Experiment			Input-to-State Stability, Part II
Coffee Break								
F 16:30-18:30			Distributed Parameter Systems: Applications and Computation, Part II					
Farewell Party								

Schedule of Events

Sunday August 11, 2002

18:00—21:00 Welcoming Reception

Center for Continuing Education

Monday August 12, 2002

8:00-8:30 *Room*: 101

Welcoming Remarks

Panos J Antsaklis,
Director, Center for Applied Mathematics
Steven Buechler,
Chair, Department of Mathematics
Jeffrey C Kantor,
Vice President

8:30-9:30 *Room*: 101 Plenary Talk

Bruce Hajek,
A Basket of System Theoretic Problems in Communications

9:30-10:30 *Room*: 101 Invited Talk

Roger Brockett,
Optimal System Identification for NMR Applications

9:30-10:30 *Room*: 102 Invited Talk

Hans-Andrea Loeliger,
Factor Graphs, Least Squares and Kalman Filtering

9:30-10:30 *Room*: 136 Invited Talk

Sjoerd Verduyn Lunel,
Control and Stabilization of Systems with Time Delays

Morning:

Room: 102, Session: MA1

Chair: Shmuel Friedland, Brian Marcus
Title: **Capacity of Multi-Dimensional Codes Part I**
11:00-13:00 **Minicourse on "Capacity of Multidimensional Codes"**,
Shmuel Friedland

Room: 126, Session: MA2

Chair: Michael D. Lemmon
Title: **Control Applications**
11:00-11:20 **Cancer Treatment Using Multiple Chemotherapeutic Agents Subject to Drug Resistance**, *John Westman, Bruce Fabijonas, Daniel Kern, Floyd Hanson*
11:25-11:45 **Selection of Decentralized Control Configurations Based on Disturbance Rejection for Plants with Real Integrators**, *Henning Schmidt*
11:50-12:10 **Synergetic Control of the Unstable Two-Mass System**, *Alexander Kolesnikov*
12:15-12:35 **Synergetic Control for Electromechanical Systems**, *Andrey Popov, Anatoly Kolesnikov, Gennady Veselov, Alexander Kolesnikov, Roger Dougal*
12:40-13:00 **Modeling of Out-of-Plane Hygroinstability of Multi-Ply Paperboard**, *Gianantonio Bortolin, Per-Olof Gutman*

Room: 136, Session: MA4

Chair: Bill Helton, Andre Ran, Leiba Rodman
Title: **Matrix and Operator Equations I**

11:00-11:30 **Noncanonical Almost Periodic Factorization and Toeplitz Operators with Almost Periodic Symbols**, *Leiba Rodman, I. M. Spitkovsky, H. J. Woerdeman*

11:30-12:00 **Symmetric Nonsquare Factorization of Selfadjoint Rational Matrix Functions and Algebraic Riccati Inequalities**, *A. C. M. Ran, Mark A. Petersen*
12:00-12:30 **Extremal Problems of Interpolation Theory**, *L. A. Sakhnovich*
12:30-13:00 **Convex Invertible Cones, Nevalinna-Pick Interpolation and the Set of Lyapunov Solutions**, *Izchak Lewkowicz, Nir Cohen*

Room: 208, Session: MA5

Chair: Lorenzo Farina, Maria Elena Valcher
Title: **Positive Systems**

11:00-11:30 **Positive Systems in the State Space Approach: Main Issues and Recent Results**, *Lorenzo Farina*
11:30-12:00 **Positive Systems in the Behavioral Approach: Main Issues and Recent Results**, *Maria Elena Valcher*
12:00-12:30 **Feedback Stabilisation with Positive Control of Dissipative Compartmental Systems**, *Georges Bastin, A. Provost*
12:30-13:00 **Feedback Control for a Chemostat with two Organisms**, *Patrick De Leenheer, Hal Smith*

Room: 209, Session: MA6

Chair: Augusto Ferrante, Michele Pavon
Title: **Control of Quantum Mechanical Systems**

11:00-11:30 **Sufficient Conditions for Controllability of Finite Level Quantum Systems via Structure Theory of Semisimple Lie Algebras**, *Claudio Altafini*
11:30-12:00 **Geometric Control of Quantum Mechanical Systems in a Noisy Environment**, *Domenico D'Alessandro*
12:00-12:30 **Control of Quantum Systems Using Model-based Feedback Strategies**, *Augusto Ferrante, Michele Pavon, Giorgio Raccanelli*
12:30-13:00 **Quantum Control of Dissipative Systems**, *Sonia G. Schirmer, A. I. Solomon*

Room: 210, Session: MA7

Chair: Peter Bauer
Title: **Adaptive Control**

11:00-11:20 **Gap Metric Robustness of Adaptive Controllers**, *Mark French*
11:20-11:40 **Adaptive Predictive Control with Controllers of Restricted Structure**, *Michael Grimble, Peter Martin*
11:40-12:00 **Output Adaptive Model Reference Control of Linear Continuous State-Delay Plant**, *Boris Mirkin, Per-Olof Gutman*
12:00-12:20 **A Comparison Between Robust Adaptive Controllers w.r.t a Non–singular Transient Cost**, *Ahmad Sanei, Mark French*
12:20-12:40 **A Manifold Structure on the set of Functional Observers**, *Jochen Trumpf, Uwe Helmke*
14:00-15:00 **On the Capacity of 2-D Constrained Codes and Consequences for Full-Surface Data Channels**, *William Weeks*

Middle:

Room: 102, Session: MM1

Chair: Shmuel Friedland, Brian Marcus
Title: **Capacity of Multi-Dimensional Codes Part II**

14:00-15:00 **On the Capacity of 2-D Constrained Codes and Consequences for Full-Surface Data Channels**, *William Weeks*
15:00-16:00 **Counting Independent Sets in The Grid, And Similar Questions**, *Neil Calkin*

Room: 126, Session: MM2

Chair: Wei Lin
Title: **Nonlinear Systems and Control 1**

14:00-14:20 **Estimating Generalized Gradients of Value Function in Optimal Control Problems for Differential-Difference Inclusions**, *Leonid Minchenko, Aleksey Volosevich*

14:20-14:40 **Interconnected Systems of Fliess Operators**, *W. Steven Gray, Yaqin Li*
14:40-15:00 **Controllability Analysis of A Two Degree of Freedom Nonlinear Attitude Control System**, *Jinglai Shen, Amit K. Sanyal, N. Harris McClamroch*
15:00-15:20 **Sliding Mode Idle Speed Ignition Control Strategies for Automotive Engines**, *Manjit Singh Srai, H. Sindano, N. E. Gough, A. C. Cole*
15:20-15:40 **Truncation and Approximation Errors in the Max-Plus Algorithm for H-infinity Control**, *William McEneaney*
15:40-16:00 **Solution of Second Order Linearization**, *Rajagopalan Devanathan*

Room: 129, Session: MM3

Chair: Giorgio Picci, Augusto Ferrante
Title: **Stochastic Systems 1**

14:00-14:30 **Canonical Correlations Between Input and Output Processes of Linear Stochastic Models**, *Katrien De Cock, Bart De Moor*
14:30-15:00 **A Regularized Cepstrum and Covariance Matching Method for ARMA(n,m) Design**, *Per Enquist*
15:00-15:30 **On Some Interpolation Problems**, *Gyorgy Michaletzky, A. Gombani*
15:30-16:00 **Non-regular Processes and Singular Kalman Filtering**, *Augusto Ferrante, Stefano Pinzoni, Giorgio Picci*

Room: 136, Session: MM4

Chair: I. Gohberg, M.A. Kaashoek
Title: **State Space Methods for Problems in Operator Theory**

14:00-14:30 **State Space Methods, Reproducing Kernel Spaces and Applications**, *Harry Dym*
14:30-15:00 **A Beurling–Lax Type Theorem in the Unit Ball**, *Daniel Alpay, Aad Dijksma, Jim Rovnyak*
15:00-15:30 **A Naimark Dilation Perspective on Positive Real Interpolation**, *A. Frazho*
15:30-16:00 **State Space Method, Explicit Solutions of Scattering Problems, and Nonlinear Integrable Equations**, *Alexander L. Sakhnovich*

Room: 208, Session: MM5

Chair: Xiaochang Wang
Title: **Output Feedback Control of Linear Systems**

14:00-14:30 **Counterexamples to Pole Placement by Real Static Output Feedback**, *Alex Eremenko, A. Gabrielov*
14:30-15:00 **Numerical Homotopy Algorithms for Satellite Trajectory Control by Pole Placement**, *Jan Verschelde, Yusong Wang*
15:00-15:30 **Numerical Schubert Calculus by the Pieri Homotopy Algorithm**, *Tien-Yien Li, Xiaoshen Wang, Mengnien Wu*
15:30-16:00 **On Minimal Order Decentralized Output Feedback Pole Assignment Problems**, *Xiaochang Wang*

Room: 209, Session: MM6

Chair: Yutaka Yamamoto
Title: **Optimization and Optimal Control**

14:00-14:20 **A Jacobi-like Method for the Indefinite Generalized Hermitian Eigenvalue Problem**, *Christian Mehl*
14:20-14:40 **Disturbed Discrete Time Linear-Quadratic Open-Loop Nash games**, *Gerhard Jank, Dirk Kremer*
14:40-15:00 **Linear Matrix Inequalities for Global Optimiztion of Rational Functions and H2 Optimal Model Reduction**, *Dorina Jibetean, Bernard Hanzon*
15:00-15:20 **Newton's Method for Optimization in Jordan Algebras**, *Sandra Ricardo, Uwe Helmke, Shintaro Yoshizawa*
15:20-15:40 **Non-symmetric Riccati Theory and Linear Quadratic Nash Games.**, *Dirk Kremer, Radu Stefan*
15:40-16:00 **Some New Results on Linear Quadratic Regulator Design for Lossless Systems**, *Maria Gabriella Xibilia, Luigi Fortuna, Giovanni Muscato*

Afternoon:

Room: 102, Session: MP1

Chair: Sandro Zampieri
Title: **The Interaction of Control, Information and Communication**

16:30-16:50 **Minimum Data Rates for Stabilising Linear Systems with Unknown Parameters**, *Girish Nair, Robin J. Evans, Björn Wittenmark*
16:50-17:10 **A Graphical Model Approach to Distributed Control**, *Sekhar Tatikonda*
17:10-17:30 **Quantized Stabilization of Single-input Nonlinear Affine Systems**, *Jialing Liu, Nicola Elia*
17:30-17:50 **Distributed Robust Controller for Complex Networks**, *Wing Shing Wong*
17:50-18:10 **Stabilizing Quantized Feedback with Minimal Information Flow: the Scalar Case**, *Fabio Fagnani, Sandro Zampieri*
18:10-18:30 **Systems of Dynamics and their Cohomological Invariants**, *Reuben Rabi, Sanjoy Mitter*

Room: 126, Session: MP2

Chair: Matthias Kawski
Title: **Nonlinear Systems and Control 2**

16:30-16:50 **Skorokhod-Neumann Boundary Conditions in Robust Queueing Service Models**, *Martin Day*
16:50-17:10 **Optimization Methods for Target Problems of Control**, *Alexander B. Kurzhanski, Pravin Varaiya*
17:10-17:30 **On Optimal Quadratic Lyapunov Functions for Polynomial Systems**, *Graziano Chesi, Alberto Tesi, Antonio Vicino*
17:30-17:50 **The Maximum Principle for an Optimal Solution to a Differential Inclusion with State Constraints**, *Aurelian Cernea*
17:50-18:10 **Synergetic Synthesis of Nonlinear Interconnected Control for Turbogenerators**, *Anatoly Kolesnikov, Andrew Kuzmenko*
18:10-18:30 **Stabilities and Controllabilities of Switched Systems (with Applications to the Quantum Systems)**, *Leonid Gurvits*

Room: 129, Session: MP3

Chair: Amarjit Budhiraja
Title: **Stochastic Control and its Applications**

16:30-17:00 **Nonlinear Filtering in Correlated Noise: a Wiener Chaos Approach**, *Sergey Lototsky*
17:00-17:30 **Stationary Solutions and Forward Equations for Controlled and Singular Martingale Problems**, *Richard H. Stockbridge*
17:30-18:00 **An Investment Model with Liquidity Risk**, *Hui Wang*
18:00-18:30 **Mean-Variance Portfolio Selection under Markov Regime: Discrete-time Models and Continuos-time Limits**, *George Yin, X. Y. Zhou*

Room: 136, Session: MP4

Chair: Harry Dym, Heinz Langer
Title: **Spaces with Indefinite Metrics and Inverse**

16 :30-17:00 **Regular and Singular Point-like Perturbations of some Differential Operators in Pontryagin Spaces**, *Aad Dijksma, Yuri Shondin*
17:00-17:30 **Applications of Spaces with Indefinite Metrics**, *Babak Hassibi*
17:30-18:00 **Sturm-Liouville Inverse Spectral Problems with Boundary Conditions Depending on the Spectral Parameter**, *Cornelis van der Mee, Vjacheslav Pivovarchik*
18:00-18:30 **Variational Principles for Block Operator Matrices**, *Christiane Tretter, Heinz Langer, Matthias Langer*

Room: 209, Session: MP5

Chair: Paul Fuhrmann
Title: **Algebraic Systems Theory**

16:30-16:50 **Further Results on Interconnection and Elimination for Delay-Differential Systems**, *Heide Gluesing-Luerssen*
16:50-17:10 **Reduction of Affine Systems on Polytopes**, *Jan H. van Schuppen, Luc C.G.J.M. Habets*

17:10-17:30 **State Feedback Stabilization with Guaranteed Transient Bounds**, *Fabian Wirth, Diederich Hinrichsen, Elmar Plischke*
17:30-17:50 **Reduction of the Number of Parameters for all Stabilizing Controllers**, *Kazuyoshi Mori*
17:50-18:10 **Structural Properties of LTI Singular Systems by Output Feedback**, *Runyi Yu, Dianhui Wang*
18:10-18:30 **On Fliess Models over a Commutative Ring**, *Vakhtang Lomadze*

Room: 210, Session: MP6

Chair: Daniel Liberzon
Title: **Hybrid Systems and Control**

16:30-17:00 **Nonlinear and Hybrid Control via RRTs**, *Michael Branicky, Michael M. Curtiss*
17:00-17:30 **Reachability Analysis of Hybrid Systems with Linear Dynamics**, *Mireille Broucke*
17:30-18:00 **Towards the Control of Linear Systems with Minimum Bit-Rate**, *Joao Hespanha, Antonio Ortega, Lavanya Vasudevan*
18:00-18:30 **Control of Hybrid Systems along Limit Cycles**, *Milos Zefran, Guobiao Song, Francesco Bullo*

20:00–22:00 *Room*: 102

Workshop on Open Problems in Systems Theory

Chairs: Vincent Blondel, Roger Brockett

Tuesday August 13, 2002

8:00-9:00 *Room*: 101 Plenary Talk

Gilbert Strang,
Filtering and Signal Processing

9:00-10:00 *Room*: 101 Invited Talk

Arjan van der Schaft,
Mathematical Theory of Network Models of Physical Systems

9:00-10:00 *Room*: 102 Invited Talk

Robert J. McEliece,
Belief Propagation on Partially Ordered Sets

9:00-10:00 *Room*: 129 Invited Talk

Jeff Wood,
Modules and Behaviors: Re-examining Oberst's Duality

Morning:

Room: 102, Session: TUA1

Chair: Heide Gluesing-Luerssen
Title: **Design and Analysis of Block Codes, Part I**

10:30-11:30 **Iterative Decoding and Design of Codes on Graphs**, *Pascal O. Vontobel*
11:30-12:00 **Codes for Networks**, *Ralf Koetter*
12:00-12:30 **Unitary Constellation Design with Application to Space-time Coding**, *Guangyue Han, Joachim Rosenthal*

Room: 126, Session: TUA2

Chair: Wijesuriya P. Dayawansa
Title: **Patterns in Biology**

10:30-11:00 **Visual Systems**, *Bijoy Gosh, A. Polpitiya*
11:00-11:30 **The Dynamics of Avian Kinesis**, *Lawrence Schovanec, Alan Barhorst, Sankar Chatterjee*
11:30-12:00 **Spiral Waves in the Heart**, *Clyde Martin, P. Marcus*
12:00-12:30 **Large Amplitude Travelling Waves in Coupled Oscillater Networks**, *Wijesura P. Dayawansa, Clyde Martin*

Room: 129, Session: TUA3

Chair: Victor Vinnikov, Joseph A. Ball
Title: **Minicourse A: Multidimensional Systems**

10:30-11:30 **Overdetermined Multidimensional Systems and Applications**, *Victor Vinnikov*
11:30-12:30 **Overdetermined Multidimensional Systems and Applications**, *Joseph A. Ball*

Room: 136, Session: TUA4

Chair: Lars Gruene, Fabian Wirth
Title: **Input-to-State Stability, Part I**

10:30-11:00 **Attractors, Input-to-State-Stability, and Control Sets**, *Fritz Colonius, W. Kliemann*
11:00-11:30 **Output-Input Stability of Nonlinear Systems and Input/Output Operators**, *Daniel Liberzon, Eduardo Sontag*
11:30-12:00 **A Parameter-Robust Observer as an Application of ISS Techniques**, *Madalena Chaves*
12:00-12:30 **Quantitative Aspects of the Input-to-state Stability Property**, *Lars Gruene*

Room: 208, Session: TUA5

Chair: Anders Rantzer
Title: **Linear Systems**

10:30-10:50 **A New Property of Laguerre Functions**, *Luigi Fortuna, Riccardo Caponetto, Mattia Frasca*
10:50-11:10 **Communication-Limited Stabilisability of Jump Markov Linear Systems**, *Girish Nair, Subhrakanti Dey, Robin Evans*
11:10-11:30 **Equivalence of Finite Pole Assignability of LTI Singular Systems by Output Feedback**, *Runyi Yu, Dianhui Wang*
11:30-11:50 **On Kalman Models over a Commutative Ring**, *Vakhtang Lomadze*
11:50-12:10 **On Rosenbrock Models over a Commutative Ring**, *Vakhtang Lomadze*
12:10-12:30 **Inclusion of Frequency Domain Behaviors**, *Stephen Prajna, Pablo A. Parrilo*

Room: 209, Session: TUA6

Chair: Viswanath Ramakrishna
Title: **Quantum Engineering I**

10:30-11:10 **A Numerical Approach to the Design of Strongly Modulating Pulses to Implement Precise Effective Hamiltonians for Quantum Information Processing,** *Timothy Havel, Nicolas Boulant, David G. Cory, Evan M. Fortunato, Marco A. Pravia, Grum Teklemariam*
11:10-11:50 **System Theoretic Aspects of NMR Spectroscopy** , *Raimund J. Ober*
11:50-12:10 **Local and Global Control of Population Transfer in Quantum Systems**, *Vladimir Malinovsky*
12:10-12:30 **Hartree-Fock Models in Electronic Structure Computations**, *Gabriel Turinici*

Room: 210, Session: TUA7

Chair: Stephen Campbell, Ramine Nikoukhah
Title: **Robust Estimation, Identification, and Detection**

10:30-11:00 **A Survey of Input-Output Methods in Robust Estimation**, *Babak Hassibi*
11:00-11:30 **Robust Least-Squares Filtering with a Relative Entropy Constraint**, *Bernard Levy, Ramine Nikoukhah*
11:30-12:00 **Bounding the Solution Set of Uncertain Linear Equations: a Convex Relaxation Approach**, *Giuseppe Calafiore, Laurent El Ghaoui*
12:00-12:30 **The Design of Auxiliary Signals for Robust Active Failure Detection in Uncertain Systems**, *Stephen Campbell, Ramine Nikoukhah*

Middle:

Room: 102, Session: TUM1

Chair: Daniel Costello
Title: **Design and Analysis of Block Codes, Part II**

14:00-14:30 **On a Few Classes of Optimal and Near-optimal Polynomial Codes**, *Nuh Aydin*
14:30-15:00 **Building Low-Density Parity-Check Codes with Affine Permutation Matrices**, *Michael O'Sullivan, Marcus Greferath, Roxana Smarandache*
15:00-15:30 **On Plotkin and Elias Bounds for Codes over Frobenius Rings under the Homogeneous Weight**, *Marcus Greferath*
15:30-16:00 **Four and Six-Dimensional Signal Constellations from Algebraic Lattices**, *Carmelo Interlando, Michele Elia*

Room: 126, Session: TUM2

Chair: Raimund Ober
Title: **Immunology 1: Introduction and Microscopy**

14:00-14:40 **Introduction to Workshop and Overview**, *Raimund Ober*
14:40-15:20 **T Cell Receptor MHC Interactions: An Overview**, *E. Sally Ward*
15:20-16:00 **Image Formation and Deconvolution for 3 Dimensional Microscopy of Cell Samples**, *Jose Angel Conchello*

Room: 129, Session: TUM3

Chair: Krzystof Galkowski, Eric Rogers, Victor Vinnikov
Title: **Multidimensional Systems 1**

14:00-15:00 **2D Linear Control Systems - From Theory to Experiment to Theory**, *Eric Rogers, Tarek Al-Towlem, James Radcliffe, Paul Lewin, Krzysztof Galkowski, David Owens*
15:00-15:30 **Stability Analysis of 2D Dynamics in Roessers Model**, *Tatsushi Ooba, Yasuyuki Funahashi*
15:30-16:00 **Algebraic Algorithm for 2D Stability Test Based on a Lyapunov Equation**, *Minoru Yamada, Li Xu, Osami Saito*

Room: 208, Session: TUM4

Chair: Joseph A. Ball, Hugo Woerdeman
Title: **Recent Developments on Interpolation and Completion Problems**

14:00-14:20 **Feedback Control for Multidimensional Systems and Interpolation Problems for Multivariable Functions**, *Joseph A. Ball, Tanit Malakorn*
14:20-14:40 **On the Caratheodory-Fejer Interpolation Problem for Generalized Schur Functions**, *Vladimir Bolotnikov*
14:40-15:00 **Abstract Interpolation in Scattering Setting**, *Alexander Kheifets*
15:00-15:20 **A Convex Optimization Approach to Generalized Moment Problems**, *Anders Lindquist, C. I. Byrnes*
15:20-15:40 **Extremal Properties of Outer Factors**, *Scott McCullough*
15:40-16:00 **On the Realization of Inverse Stieltjes Functions**, *E. R. Tsekanovskii, Sergey Belyi, Seppo Hassi, Henk de Snoo*

Room: 209, Session: TUM5

Chair: Damir Arov
Title: **Control of Distributed Parameter Systems**

14:00-14:30 **Optimal Control and Riccati Equations for a Degenerate Parabolic System**, *Jean-Marie Buchot, Jean-Pierre Raymond*
14:30-15:00 **Nonlinear Predictive Control of Flexible Manipulator Systems**, *Alaa Mohamedy, Andrzej Ordys, Michael Grimble*
15:00-15:30 **Furtivity and Masking Problems in Acoustics**, *Francesco Zirilli*
15:30-16:00 **Approximation of Optimal Controls for Semi-Linear Parabolic PDE by Solving Hamilton-Jacobi-Bellman Equations**, *Sophie Gombao*

Room: 210, Session: TUM6

Chair: Anders Lindquist
Title: **Filtering and Identification**

14:00-14:20 **System Identification of Nonlinear Dynamic Systems with Multiple Inputs and Single Output Using Discrete-Time Volterra Type Equations**, *Thomas Treichl, Stefan Hofmann, Dierk Schröder*
14:25-14:45 **Data Driven Local Coordinates**, *Thomas Ribarits, Manfred Deistler, Bernard Hanzon*
14:50-15:10 **Using Rank Order Filters to Decompose the Electromyogram**, *Dawnlee Roberson, Cheryl Schrader*
15:15-15:35 **Conditioning Analysis of a Continuous Time Subspace-Based Model Identification Algorithm**, *Juan Carlos Martinez-Garcia, G.H. Salàzar-Silva, R. Garrido*
15:40-16:00 **On Model and State Estimation under Mixed Uncertainty**, *Irina Digailova, Alexander B.Kurzhanski*

Afternoon:

Room: 102, Session: TUP1

Chair: Heide Gluesing-Luerssen
Title: **Convolutional Codes**

16:30-17:00 **Construction and Decoding of Strongly MDS Convolutional Codes**, *Roxana Smarandache, Heide Gluesing-Luerssen, Joachim Rosenthal*
17:00-17:30 **On Observers and Behaviors**, *Paul A. Fuhrmann*
17:30-18:00 **On the Convergence of Non-systematic Turbo Codes**, *Daniel Costello Jr., Adrish Banerjee, Francesca Vatta, Bartolo Scanavino*
18:00-18:30 **Some Small Cyclic Convolutional Codes**, *Heide Gluesing-Luerssen, Wiland Schmale, Melissa Striha*

Room: 126, Session: TUP2

Chair: Raimund Ober
Title: **Immunology 2: Microscopy and Biophysics**

16:30-17:10 **Microscopic Investigation of Synapse Formation**, *Michael Dustin*
17:10-17:50 **Studying Protein-Protein Interactions: Biosensor Technology**, *Peter Schuck*
17:50-18:30 **Protein Dynamics Near Membrane Surfaces: New Aspects of Local Coupled Reaction and Transport**, *Nancy L. Thompson*

Room: 129, Session: TUP3

Chair: Krzystof Galkowski, Eric Rogers, Victor Vinnikov
Title: **Multidimensional Systems 2**

16:30-17:00 **State Representation of nD Behaviors**, *Isabel Brás, Paula Rocha*
17:00-17:30 **The Bang-Bang Principle for the Goursat-Darboux Problem**, *Dariusz Idczak*
17:30-18:00 **Elimination of Anticipation of Singular 2D Roesser Model**, *Tadeusz Kaczorek*
18:00-18:30 **Difference Equations and n-D Discrete Systems**, *Jiri Gregor*

Room: 136, Session: TUP4

Chair: Matthias Kawski
Title: **Nonlinear Systems and Control 3**

16:30-16:50 **Disturbance Attenuation for a Class of Nonlinear Systems by Output Feedback**, *Wei Lin, Xianqing Huang, Chunjiang Qian*
16:50-17:10 **A Linear Controller for a Multifrequency Model of a Pulse-Width-Modulated Cuk Converter**, *Yusuf Fuad, J.W. van der Woude, W.L. de Koning*
17:10-17:30 **Synergetic Synthesis of Nonlinear Kinematics Regulators for Mobile Robots**, *Boris Topchiev*
17:30-17:50 **On the Convergence of a Feedback Control Strategy for Multilevel Quantum Systems**, *Paolo Vettori*
18:10-18:30 **Global Output Feedback Control with Disturbance Attenuation for a Class of Nonlinear Systems**, *Xianqing Huang, Wei Lin*

Room: 209, Session: TUP5

Chair: Ruth Curtain
Title: **Infinite Dimensional Systems**

16:30-17:00 **Observability Analysis of a Nonlinear Tubular Reactor**, *Cedric Delattre, Denis Dochain, Joseph Winkin*
17:00-17:30 **A Hilbert Space Approach to Self-Similar Systems**, *Mamadou Mboup*
17:30-18:00 **Boundary Observability in the Quasi-Static Thermoelastic Contact Problem**, *Michael Polis, Irina Sivergina*
18:00-18:30 **Modeling Distributed Parameter Systems with Discrete Element Networks**, *Fabien Soulier, Patrick Lagonotte*

Room: 210, Session: TUP6

Chair: Avraham Feintuch
Title: **Robust and H-Infinity Control and Estimation**

16:30-16:50 **Simultaneous Robust Regulation and Robust Stabilization with Degree Constraint**, *Ryozo Nagamune*
16:50-17:10 **Closed-Loop Structure of DiscreteTime H-infinity Controller**, *Waree Kongprawechnon, Shun Ushida, Hidenori Kimura*
17:10-17:30 **On a Recursive State-space Method for Discrete-time H_2-Approximation**, *Ralf Peeters, Martine Olivi, Bernard Hanzon*
17:30-17:50 **PID Robust Control via Genetic Algorithms and Integral Criteria Minimization**, *Catalin Nicolae Calistru, Oana Geman*
17:50-18:10 **MIMO Systems Properties Preservation under SPR Substitutions**, *Juan Carlos Martinez-Garcia, G. Fernàndez-Anaya*
18:10-18:30 **State Feedback Mixed H2/H-Infinity Problem for Linear Systems with Finite Jumps**, *Vasile Dragan, Adrian Stoica*

20:00–22:00 *Room*: 102

Workshop on Open Problems in Systems Theory

Chairs: Anders Rantzer, Eduardo Sontag and Jan C. Willems

Wednesday August 14, 2002

8:00-9:00 *Room*: 101 Plenary Talk

J. William Helton,
Manipulating Matrix Inequalities Automatically

9:00-10:00 *Room*: 101 Invited Talk

Jan C. Willems,
Dissipative Distributed Systems

9:00-10:00 *Room*: 102 Invited Talk

Albert-Laszlo Barabasi,
The Architecture of Complexity: Emergence of Scaling in Complex Networks

9:00-10:00 *Room*: 136 Invited Talk

Knut Hueper,
The Dynamics of Matrix Eigenvalue Algorithms

Morning:

Room: 102, Session: WA1

Chair: Raimund Ober
Title: **Immunology 3: Structure and Kinetics**

10:30-11:10 **Geometrical Methods in Structural Molecular Biology**, *Timothy F. Havel*
11:10-11:50 **Kinetic aspects of TcR-MHC and Antibody-Antigen Interactions**, *Jefferson Foote*
11:50-12:30 **Biophysical Considerations of T-Cell Receptor-Peptide/MHC Interactions**, *Brian M. Baker*

Room: 126, Session: WA2

Chair: Martin Haenggi
Title: **Computer Networks**

10:30-10:50 **Min-Plus System Theory Applied to Communication Networks**, *Patrick Thiran, Jean-Yves Le Boudec*
10:55-11:15 **Elements of Probabilistic Network Calculus for Packet Scale Rate Guarantee Nodes**, *Milan Vojnovic, Jean-Yves Le Boudec*
11:20-11:40 **Statistical Performance Analysis of a Generalized Processor Sharing System by Using Large Deviations**, *Min Xie, Martin Haenggi*
11:45-12:05 **Resource Allocation and Congestion Control in Distributed Sensor Networks - a Network Calculus Approach**, *Jinsong Zhang, Kamal Premaratne, Peter Bauer*
12:10-12:30 **Optimal Media Streaming in a Rate-Distortion Sense For Guaranteed Service Networks**, *Olivier Verscheure, Pascal Frossard*

Room: 129, Session: WA3

Chair: Eric Rogers
Title: **Minicourse B: Multidimensional Systems**

10:30-11:10 **Recent Results on Multidimensional Behaviors**, *Eva Zerz*
11:10-11:50 **Motivation and General Concepts in Behavioral Systems**, *Jan C. Willems*
11:50-12:30 **Similarities/Differences between the Behavioral Approach for Multidimensional versus Delay-Differential Systems**, *Heide Gluesing-Luerssen*

Room: 136, Session: WA4

Chair: Paul Van Dooren
Title: **Model Reduction**

10:30-10:50 **An Overview of Model Reduction Methods for Large-Scale Dynamical Systems**, *Thanos Antoulas*
10:50-11:10 **Analysis of Smith-Type Methods for Lyapunov Equations and Balanced Model Reduction**, *Dan Sorensen*
11:10-11:30 **Krylov Subspace Techniques for Reduced Order Modeling of Nonlinear Dynamical System**, *Daniel Skoogh, Zhaojun Bai*
11:30-11:50 **Model Reduction of Second Order Systems**,
Younes Chahlaoui, D. Lemonnier, K. Meerbergen, A. Vandendorpe, P. Van Dooren
11:50-12:10 **Model Reduction via Tangential Interpolation**, *Antoine Vandendorpe, K. Gallivan, P. Van Dooren*

Room: 208, Session: WA5

Chair: Daniel Alpay, Yuli Eidelman
Title: **Time-Varying Systems and Numerical Problems**

10:30-11:00 **Unbounded J-inner Sections**, *Patrick Dewilde, Daniel Alpay*
11:00-11:30 **Linear Time-Varying Darlington Synthesis**, *Avraham Feintuch*
11:30-12:00 **Reduction to System Methods for Inversion of Diagonal Plus Semiseparable Operator Matrices**, *Yuli Eidelman, Israel Gohberg*

Room: 209, Session: WA6

Chair: Erik Verriest
Title: **Nonlinear Systems and Control 4**

10:30-11:00 **Parameter Tuning of a Non Integer Order PID Controller**, *Luigi Fortuna, Riccardo Caponetto, Domenico Porto*
11:00-11:30 **Nonlinear Discrete-Time Observer Design with Linearizable Error Dynamics**, *MingQing Xiao, Nikolaos Kazantzis, Costas Kravaris, Arthur J Krener*
11:30-12:00 **Analysis of Periodic Solutions of Tapping-Mode AFM: An IQC Approach**, *Murti Salapaka, Abu Sebastian*
12:00-12:30 **Bifurcations of the Controlled Escape Equation**, *Tobias Gayer*

Room: 210, Session: WA7

Chair: Rodolphe Sepulchre
Title: **Discrete Event and Hybrid Systems**

10:30-10:50 **Switched Systems that are Periodically Stable may be Unstable**, *Jacques Theys, Vincent Blondel, Alexander Vladimirov*
10:50:11:10 **The Servo Problem for Piecewise Linear Systems**, *Stefan Solyom, Anders Rantzer*
11:10-11:30 **Stability of Hybrid Control Systems Based on Time-State Control Forms**, *Yoshikatsu Hoshi, Mitsuji Sampei, Shigeki Nakaura,*
11:30-11:50 **Discrete-Time Modeling and Analysis of Pulse-Width-Modulated Switched Power Converters**, *Willem L. De Koning*
11:50-12:10 **On the Control of the Resonant Converter: A Hybrid-Flatness Approach**, *Hebert Sira-Ramirez, Ramon Silva-Ortigoza*
12:10-12:30 **Controllability of Periodically Switched Linear Systems with Delay in Control**, *Guangming Xie, Long Wang, Yijing Wang*

Middle:

Room: 102, Session: WM1

Chair: Raimund Ober
Title: **Immunology 4: Diffusion and Modelling**

14:00-14:40 **Measuring Lateral Diffusion and Associations of MHC Molecules in Membranes of the ER and at the Cell Surface**, *Michael Edidin*
14:40-15:20 **A Computational Model for T Cell Receptor Signal Integration**, *Mark Alber, Arancha Casal, Cenk Sumen, Tim Reddy, Mark Davis, Peter Lee*
15:20-16:00 **Immunological Synapse Formation: A Crossroad of Physical Chemistry and Cell Biology**, *Arup K. Chakraborty*

Room: 126, Session: WM2

Chair: Aleksandar Kavcic
Title: **Control and Communications**

14:00-14:20 **Feedback Capacity**, *Sekhar Tatikonda, Sanjoy Mitter*
14:20-14:40 **Sum-Product Algorithm and Feedback Capacity**, *Shaohua Yang, Aleksandar Kavcic*
14:40-15:00 **Kalman Filtering, Factor Graphs, and Electrical Networks**, *Pascal O. Vontobel, Dani Lippuner, Hans-Andrea Loeliger*
15:00-15:20 **Kalman Filtering Applied to Timing Recovery in Tracking Mode**, *Panu Chaichanavong, Brian Marcus*
15:20-15:40 **Lower Bounds for the Performance of Iterative Timing Recovery at low SNR**, *Aravind Nayak, J. Barry, S. McLaughlin*
15:40-16:00 **Classical Capacity of Quantum Channels**, *Navin Khaneja*

Room: 129, Session: WM3

Chair: Krzystof Galkowski, Eric Rogers, Victor Vinnikov
Title: **Multidimensional Systems 3**

14:00-15:00 **Conservative Multidimensional Systems: A Survey**, *Joseph A. Ball*
15:00-15:30 **On J-Conservative Scattering nD System Realizations**, *Dmitry Kalyuzhniy-Verbovetzky*
15:30-16:00 **Factorization of M-D Polynomial Matrices for Design of M-D Multirate Systems**, *Mikhail Tchobanou, Cynthia Woodburn*

Room: 136, Session: WM4

Chair: Uwe Helmke
Title: **Control and Computation**

14:00-14:30 **Continuation of Eigendecompositions**, *Luca Dieci*
14:30-5:00 **Numerical Solution of Euclidean Balanced Norm Realizations via Gradient Flows**, *N. Del Buono, L. Lopez*

15:00-15:30 **Controllability of the QR Algorithm on Hessenberg Flags**, *Uwe Helmke, Jens Jordan*
15:30-16:00 **The Continuos-Time Rayleigh Quotient Flow on the Grassmann Manifold**, *Rodolphe Sepulchre, P.-A. Absil, R. Mahony*

Room: 209, Session: WM5

Chair: Anthony Bloch
Title: **Algebraic and Differential Geometry in Systems Theory**

14:00-14:20 **Hamiltonian Structure of the Algebraic Riccati Equation and its Infinitesimal V-Stability**, *Nanaz Fathpour, Edmond A. Jonckheere*
14:20-14:40 **Global Transformation of Nonlinear Dynamic Systems into Canonical Forms**, *Anna Michtchenko, Aleksey Zhirabok*
14:40-15:00 **A Lie-Group Approach for Nonlinear Dynamic Systems Described by Implicit Ordinary Differential Equations**, *Kurt Schlacher, Andreas Kugi, Kurt Zehetleitner*
15:00-15:20 **Quotients of Fully Nonlinear Control Systems**, *Paulo Tabuada, George J. Pappas*
15:20-15:40 **The Wave Equation as a Port-Hamiltonian System, and a Finite Dimensional Approximation**, *Viswanath Talasila, Goran Golo, Arjan van der Schaft*
15:40-16:00 **Pseudo Balancing for Discrete Nonlinear Systems**, *Erik Verriest*

Room: 210, Session: WM6

Chair: Panos Antsaklis, Anthony Michel
Title: **Hybrid Control System Analysis, Synthesis and Diagnosis**

14:00-14:30 **Partial Stability of Dynamical Systems**,
Ye Sun, A.N. Michel, A.P. Molchanov
14:30-15:00 **An Approach to General Switched Linear Quadratic Optimal Control Problems with State Jumps**, *Xuping Xu, Panos Antsaklis*
15:00-15:30 **The Controlled Composition Analysis of Hybrid Automata**, *Ying Shang, M.D. Lemmon*
15:30-16:00 **Monitoring and Diagnosis of Hybrid Systems Using Particle Filtering Methods**, *Xenofon Koutsoukos, James Kurien, Feng Zhao*

Room: 208, Session: WM7

Chair: Giorgio Picci
Title: **Stochastic Systems 2**

14:00-14:30 **State Space Realization of Random Processes with Feedback**, *Giorgio Picci, Alessandro Chiuso*
14:30-15:00 **Approximate Realization of Hidden Markov Chains**, *Lorenzo Finesso*
15:00-15:30 **Random Sampling of a Continuous-Time Stochastic Dynamical System**, *Mario Micheli, Michael I. Jordan*
15:30-16:00 **The Hilbert Space of an Ergodic Sequence**, *Giorgio Picci*

Afternoon:

Room: 102, Session: WP1

Chair: Raimund Ober
Title: **Immunology 5: Cellular Aspects**

16:30-17:30 **Staining Antigen Specific CD4+ T -Cells with Class II MHC Oligomers**, *Lawrence Stern*
17:10-17:40 **The Roles of Serial Engagement and Kinetic Proofreading in Peptide-Induced T-Cell Activation**, *Dan Coombs, Carla Wofsy, Byron Goldstein*

Room: 126, Session: WP2

Chair: Roxana Smarandache
Title: **Cryptography**

16:30-17:00 **A High-Speed Processing for RSA Cryptograms Using High-Radix Signed-Digit Numbers and a New Algorithm of Modulo Operation**, *Yoshinori Fujisawa, Yasushi Fuwa*

17:00-17:30 **On the Rational Cubic Curve Cryptosystems**, *Xiaochang Wang, Heather Henkel*
17:30-18:00 **Public Key Cryptography Based on Simple Modules over Simple Rings**, *Gerard Maze, Christopher Monico, Joan-Josep Climent, Joachim Rosenthal*

Room: 129, Session: WP3

Chair: Krzystof Galkowski, Eric Rogers, Victor Vinnikov
Title: **Multidimensional Systems 4**

16:30-17:00 **Spatial Restoration with Reduced Boundary Error**, *Nirmal Bose, Jaehoon Koo*
17:00-17:30 **On Succesive Packing Approach to Multidimensional (M-D) Interleaving**, *Sankar Basu, Xi Min Zhang, Yun Q. Shi*
17:30-18:00 **Matrix Functions in Homomorphic Signal Processing**, *Eduard Krajnik*
18:00-18:30 **Cellular Automata in Image Processing**, *Adriana Popovici, Dan Emanuel Popovici*

Room: 136, Session: WP4

Chair: Biswa Nath Datta, Floyd B. Hanson
Title: **Large-Scale Computations in Control**

16:30-16:50 **Projection Methods for Reduced Order Modeling with Guaranteed Stability**, *Thanos Antoulas*
16:55-17:15 **Computational Methods for Portfolio and Consumption Policy Optimization in Log-Normal Diffusion, Log-Uniform Jump Environments**, *Floyd B. Hanson, J. J. Westman*
17:20-17:40 **Partial Eigenvalue Assignment in Linear Systems: Existence, Uniqueness and Numerical Solution**, *Biswa N. Datta, Daniil Sarkissian*
17:45-18:05 **Model Reduction via an Explicitly Restarted Lanczos Algorithm**, *Vasilios Papakos, Imad M. Jaimoukha*

Room: 208, Session: WP5

Chair: J. William Helton
Title: **Expressing Polynomials as Sums of Squares Together with Applications**

16:30-17:10 **How to Write a Polynomial as a Sum of Squares of Polynomials, and Why You'd Want to Do So**, *Bruce Reznick*
17:10-17:30 **Applications of Our Newfound Facility in Expressing Polynomials as Sums of Squares.**, *Pablo A. Parrilo*
17:30-17:50 **Reduced Representations of Positive Polynomials**, *Mihai Putinar*
17:50-18:10 **Recent Progress in Polynomial Optimization**, *Ruchira Datta*
18:10-18:30 **Bounding Linear PDEs via Semidefinite Optimization**, *Constantine Caramanis, Dimitris Bertsimas*

Room: 209, Session: WP6

Chair: Viswanath Ramakrishna
Title: **Quantum Engineering II**

16:30-17:10 **Optimal Control of Laser Cooling: A Theory of Purity Increasing Transformations**, *David Tannor, Shlomo Sklarz*
17:10-17:30 **Controllability of Pairs of Coupled Quantum Dots**, *Viswanath Ramakrishna*
17:30-17:50 **Constructive Control of Quantum Systems**,
Sonia Schirmer, A.D. Greemtree
17:50-18:10 **Use of Wei-Norman Formulae and Parameter Differentiation in Quantum Control**,*Claudio Altafini*
18:10-18:30 **Control of Quantum Mechanical Systems with Minimum Number of Switches**, *Domenico D' Alessandro*

20:00–22:00 *Room*: 102

Panel Discussion on Future Directions of Research and Teaching in Mathematical Control and Systems Theory,

Biswa Datta, Organizer.

Thursday August 15, 2002

8:00-9:00 *Room*: 101 Plenary Talk

Eduardo Sontag,
On Systems Molecular Biology and Control Theory

9:00-10:00 *Room*: 126 Invited Talk

Olof Staffans,
Passive and Conservative Infinite-Dimensional Impedance and Scattering Systems (from a Personal Point of View)

9:00-10:00 *Room*: 129 Invited Talk

Wolfgang J. Runggaldier,
On Stochastic Control in Finance

9:00-10:00 *Room*: 136 Invited Talk

Matthias Heinkenschloss,
Domain Decomposition Approaches for the Optimization of Distributed Systems

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Morning:

Room: 102, Session: THA1

Chair: Mark Alber
Title: **Complex Networks and Biological Applications 1**

10:30-11:10 **The Spread of Infections on Social Networks**, *Mark Newman*
11:10-11:50 **Information Theory Aspects of Signal Transduction and Gene Regulation**, *Andrea Levchenko*

Room: 126, Session: THA2

Chair: Ruth Curtain, Olof Staffans
Title: **Distributed Parameter Systems: Theory Part I**

10:30-10:50 **Some Results on the Theory of Linear Time-Invariant Dissipative Systems with Hilbert and Pontryagin State Spaces**, *Damir Arov*
10:55-11:15 **Explicit Formulae for J-Spectral Factors for Well-Posed Systems**, *Ruth Curtain, Amol J. Sasane*
11:20-11:40 **A Riccati Equation Approach to the Standard Infinite-Dimensional H-Infinity Problem**, *Kalle M. Mikkola, Olof Staffans*
11:45-12:05 **Sub-optimal Hankel Norm Approximation for the Wiener Class**, *Orest Iftime, Amol Sasane*
12:10-12:30 **LQG Balancing in Infinite Dimensions**, *Mark R. Opmeer, Ruth Curtain*

Room: 129, Session: THA3

Chair: J.M. (Hans) Schumacher
Title: **Systems and Control Theory in Finance and Insurance 1**

10:30-11:30 **Control and Financial Engineering**, *J. M. (Hans) Schumacher*
11:30-12:00 **Dynamic Risk Sensitive Asset Management With Nonnegative Multiple Factor Constraints**, *Arunabha Bagchi, K. Suresh Kumar*
12:00-12:30 **A Filtered No-arbitrage Model for Term Structures from Noisy Data**, *Andrea Gombani, Stefan R. Jaschke, Wolfgang J. Runggaldier*

Room: 136, Session: THA4

Chair: David Nicholls
Title: **Fully Nonlinear, Three-Dimensional, Surface Water Waves in Arbitrary Depth**

10:30-11:00 **Experiments on Deep-Water Waves with Two-Dimensional Surface Patterns**, *Diane Henderson*
11:00-11:30 **Instability of Bounded Solutions of the 2-D Cubic Nonlinear Schrodinger Equation**, *John Carter*
11:30-12:00 **Computing (quasi) Periodic Waves in Shallow Water**, *Bernard Deconinck*
12:30-13:00 **Mathematical Models of Deep-Water Waves with two-Dimensional Surface Patterns**, *Harvey Segur*

Room: 208, Session: THA5

Chair: Krzystof Galkowski, Eric Rogers, Victor Vinnikov
Title: **Multidimensional Systems 5**

10:30-11:00 **Robust Stability and Stabilization of n-D Systems**, *Jiang-Qian Ying, Li Xu, Masayuki Kawamata*
11:00-11:30 **Succesive stabilization of a class of 2D systems**, *Krzysztof Galkowski, Bartek Sulikowski, Eric Rogers, David H. Owens*
11:30-12:00 **Optimal Control for a Class of Differential Linear Repetitive Processes**, *Eric Rogers, S. Dymkou, M. Dymkov, K. Galkowski, D. H Owens*
12:00-12:30 **Relation between Eigenvalues and Singular Values in the Problem of Stability Maintenance of Ellipsoidal Estimates**, *Taalaibek A. Akunov, Anatoly V. Ushakov*

Room: 209, Session: THA6

Chair: Koichi Hashimoto
Title: **Globally Stable Robust Visual Servoing**

10:30-11:00 **Keeping Features in the Camera's Field of View: a Visual Servoing Strategy**, *Graziano Chesi, K. Hashimoto, D. Prattichizzo, A. Vicino*
11:00-11:30 **Binocular Visual Servoing with a Limited Field of View**, *Noah Cowan*
11:30-12:00 **Visual Servoing with Dynamics: Control of an Unmanned Blimp**, *Jim Ostrowski*
12:00-12:30 **Enlarging the Stable Region of Image Based Control by Path Planning**, *Youcef Mezouar*

Room: 210, Session: THA7

Chair: Bill Helton, Andre Ran, Leiba Rodman
Title: **Matrix and Operator Equations II**

10:30-11:00 **Noncommutative Convexity of Functions and Sets**, *J. William Helton*
11:00-11:30 **Symmetry Groups, Semidefinite Programming,and Sums of Squares**, *Pablo A. Parrilo*
11:30-12:00 **The Symmetric Linear Matrix Equation**, *Martine C. B. Reurings*
12:00-12:30 **Investigating Duality on Stability Conditions**, *Mauricio de Oliveira*

Middle:

Room: 102, Session: THM1

Chair: Mark Alber
Title: **Complex Networks and Biological Applications 2**

14:00-14:40 **Synchronization of Oscillators in Small World Systems**, *Lou Pecora*
14:40-15:20 **Intracellular signaling is dependent on the cytoskeleton. Evidence from proteomics.**, *Gabor Forgas*
15:20-16:00 **The Role of Scale-free Connectivity Patterns in Spreading Phenomena**, *Alessandro Vespignani*

Room: 126, Session: THM2

Chair: Ruth Curtain, Olof Staffans
Title: **Distributed Parameter Systems: Theory Part II**

14:00-14:30 **Zeros of SISO Infinite-Dimensional Systems**, *Kirsten Morris, Richard Rebarber*
14:30-15:00 **Stabilizability of Systems with Signals in $\ell_2(\mathbb{Z})$**, *Birgit Jacob*
15:00-15:30 **Stability and Boundedness of Continuous and Discrete-Time Systems**, *Hans Zwart, B.Z. Guo*
15:30-16:00 **Coprimeness Conditions for Pseudorational Transfer Functions**, *Yutaka Yamamoto*

Room: 129, Session: THM3

Chair: J.M. (Hans) Schumacher
Title: **Systems and Control Theory in Finance and Insurance 2**

14:00-15:00 **Ruin Probabilities Minimization and Dividend Distribution Optimization in Diffusion Models**, *Michael Taksar*

15:00-15:30 **Continuous-Time Mean-Variance Portfolio Selection with Markov-Modulated Market Parameters**, *Xun Yu Zhou*
15:30-16:00 **Stock Selection Based on Cluster and Outlier Analysis**, *Steven Craighead, Bruce Klemesrud*

Room: 136, Session: THM4

Chair: Paul Van Dooren
Title: **Robust Control and Linear Matrix Inequalities**

14:00-14:30 **Linear Matrix Inequalities in Robust Control: A Brief Survey**, *Venkataramanan Balakrishnan*
14:30-15:00 **Periodic Multirate Systems, nu-Gap and Robust Stabilization**, *Li Qiu, Li Chai*
15:00-15:30 **Spectral Factorization and Sums of Squares via Semidefinite Programming**, *Hugo Woerdeman*
15:30-16:00 **Robustness Analysis via Stability Radii, Spectral Value Sets and mu-Functions**, *Michael Karow*

Room: 208, Session: THM5

Chair: Maria Elena Valcher
Title: **The Behavioral Approach to Dynamic Systems**

14:00-14:30 **Deterministic Kalman Filtering**, *Jan C. Willems*
14:30-15:00 **Over-Determined Systems**, *Eva Zerz*
15:00-15:30 **Regular Implementability nD Behaviors**, *Paula Rocha*
15:30-16:00 **Cones of Trajectories as Subsets of Linear Systems: the Autonomous Case**, *Andrea Morettin*

Room: 209, Session: THM6

Chair: Naomi Leonard
Title: **Control and Dynamics of Mechanical Systems I**

14:00-14:20 **Composition of Dirac Structures and Control of Port-Hamiltonian Systems**, *Arjan van der Schaft, J. Cervera*
14:20-14:40 **Hamiltonian Attitude Dynamics for a Spacecraft with a Point Mass Oscillator**, *Craig Woolsey*
14:40-15:00 **Controllable Kinematic Reductions for Mechanical Systems: Concepts, Computational Tools, and Examples**, *Andrew Lewis, Francesco Bullo, Kevin M. Lynch*
15:00-15:20 **Matching and Stabilization of Linear Mechanical Systems**, *Dimitri Zenkov*
15:20-15:40 **Matching and Stabilization of Constrained Systems**, *Guido Blankenstein*
15:40-16:00 **Extremal Flows on Stiefel Manifolds, and Riemannian Potatoes**, *Peter Crouch, Anthony M. Bloch*

Room: 210, Session: THM7

Chair: Jan van Schuppen
Title: **Control and Algebra**

14:00-14:30 **Control and Algebra - An Introduction**, *Jan H. van Schuppen*
14:30-15:00 **Towards an Algebraic Systems Theory of Hybrid Systems**, *George J. Pappas*
15:00-15:30 **The Category of a Affine Connection Control Systems**, *Andrew Lewis*
15:30-16:00 **Coalgebra and Supervisory Control with Partial Observations**, *Jan Komenda*

Afternoon:

Room: 102, Session: THP1

Chair: Mark Alber
Title: **Complex Networks and Biological Applications 3**

16:30-17:00 **Connections Matter: A Boolean Model for the Segment Polarity Network of Drosophila Melanogaster**, *Reka Albert*
17:00-17:30 **Modeling Mesenchymal Condensation during Limb Chondrogenesis**, *Gilberto Tomas*
17:30-18:00 **Classification of scale-free networks**, *Byungnam Kahng*

18:00-18:30 **Prediction of Protein Essentiality Based on Genomic Data**, *Hawoong Jeoong, Zoltan N. Oltvai and Albert-Laszlo Barabasi*

Room: 126, Session: THP2

Chair: Kirsten Morris, Olof Staffans
Title: **Distributed Parameter Systems: Stabilization and Control, Part I**

16:30-17:00 **Reciprocals of Regular Linear Systems: a Survey.**, *Ruth Curtain*
17:00-17:30 **H-infinity Control of Acoustic Noise in a Duct with a Feedforward Configuration**, *Kirsten Morris*
17:30-18:00 **Positivity and Dissipativity of Oscillating Diffusive Filters, Application to the Stability of Coupled Systems**, *G. Dauphin, Denis Matignon*
18:00-18:30 **Can Positive Pseudo-Differential Operators of Diffusive Type Help Stabilize Unstable Systems?**, *Denis Matignon*

Room: 129, Session: THP3

Chair: Tyrone Duncan
Title: **Stochastic Theory and Applications**

16:30-17:00 **An Approach to Stochastic Integration for Fractional Brownian Motion in a Hilbert Space**, *Tyrone Duncan, B. Pasik-Duncan, J. Jakubowski*
17:00-17:30 **A Class of Tractable Partially Observed Discrete Stochastic Games**, *William McEneaney*
17:30-18:00 **Hybrid Stock Models and Parameter Estimation**, *George Yin, Q. Zhang, K. Yin*
18:00-18:30 **Jump-Diffusion Stock Return Models in Finance: Stochastic Process Density with Uniform-Jump Amplitude**, *Floyd B. Hanson, J. J. Westman*

Room: 136, Session: THP4

Chair: Georg Heinig, Vadim Olshevski
Title: **Computational Methods for Structured Matrices and Applications**

16:30-17:00 **Split Algorithms for Toeplitz and Toeplitz-plus-Hankel Matrices**, *Georg Heinig*
17:00-17:30 **Structured LDPC Codes**, *Amin Shokrollahi*
17:30-18:00 **Efficient Matrix Computations in Wideband Communications**, *Patrick Dewilde, Lang Tong, Alle-Jan van der Veen*
18:00-18:30 **Stable Factorization of Hankel and Hankel-like Matrices**, *Vadim Olshevsky, Michael Stewart*

Room: 209, Session: THP5

Chair: Naomi Leonard
Title: **Control and Dynamics of Mechanical Systems II**

16:30-16:50 **On the Ball and Beam Problem: Regulation with Guaranteed Transient Performance and Tracking Periodic Orbits**, *Romeo Ortega, Fabio Gomez-Estern, Javier Aracil, Francisco Gordillo*
16:50-17:10 **Reduction of Controlled Lagrangian Systems with Symmetries**, *Dong Eui Chang*
17:10-17:30 **Constrained Mechanical Systems with Impacts**, *Patrick Hagerty*
17:30-17:50 **Adjoints of Hamiltonian Systems and Iterative Learning Control**, *Kenji Fujimoto, Toshiharu Sugie*
17:50-18:10 **Controllability of Mechanical Systems with Constraints and Symmetry**, *Jorge Cortes, Sonia Martínez, Jim P. Ostrowski, Hong Zhang*
18:10-18:30 **The Use of Information in Swarm Motions of Autonomous Vehicles**, *John Baillieul*

Room: 210, Session: THP6

Chair: Jan Willem Polderman
Title: **New Approaches to Adaptive Control**

16:30-16:50 **Cautious Hierarchical Switching Control of Stochastic Linear Systems**, *Marco Campi, Jaoa Hespanha, M. Prandini*
16:50-17:10 **Strong Robustness in Multi-Phase Adaptive Control: the Basic Scheme**, *Maria Cadic, Jan Willem Polderman*
17:10-17:30 **Near Optimal LQR Performance for Uncertain First Order Systems**, *Daniel Miller, Li Luo*

17:30-17:50 **Self-Tuning Control for Polynomial Systems: an Algorithmic Perspective**, *Iven Mareels*
17:50-18:10 **Geometry of Adaptive Control, Part II: Optimization and Geodesics**, *Felipe Pait, Diego Colon*
18:10-18:30 **Two Scale High Gain Adaptive Control**, *Jan Willem Polderman, Iven Mareels*

19:00—22:00 Banquet Dinner

Center for Continuing Education

Friday August 16, 2002

8:00-9:00 *Room*: 101 Plenary Talk

Anthony Bloch,
Conservative and Dissipative Dynamics in Classical and Quantum Systems.

9:00-10:00 *Room*: 101 Invited Talk

Raffaello D'Andrea,
A State Space Approach to Control of Spatially Interconnected Systems

9:00-10:00 *Room*: 102 Invited Talk

Allen Tannenbaum,
Controlled Active Vision in Image Guided Surgery and Therapy.

9:00-10:00 *Room*: 126 Invited Talk

Karl Kunisch,
From Viscoelastic Fluids to Constrained Optimal Control

Morning:

Room: 102, Session: FA1

Chair: Reinhard Laubenbacher
Title: **Genetic Networks**

10:30-11:00 **Biochemistry by Numbers: Modeling, Signaling and Genetic Networks**, *Pedro Mendes, Alberto de la Fuente, Paul Brazhnik, Stefan Hoops*
11:00-11:30 **Designer Gene Networks**, *Mads Kaern, James J. Collins*
11:30-12:00 **Function, Design, and Gene Circuitry**, *Michael A. Savageau*
12:00-12:30 **Comparative analysis of mathematical models of intracellular networks**, *Vassily Hatzimanikatis, Amit Mehra, Michael Beste*

Room: 126, Session: FA2

Chair: Belinda King, Kirsten Morris
Title: **Distributed Parameter Systems: Stabilization and Control, Part II**

10:30-10:50 **An Example of Output Regulation for Distributed Parameter Systems with Infinite Dimensional Exosystem**, *David Gilliam, Christopher I. Byrnes, Jeff B. Hood, Victor I. Shubov*
10:50-11:10 **Control of Systems with Infinitely Many Unstable Modes and Strongly Stabilizing Controllers Achieving a Desired Sensitivity**, *Suat Gümüşsoy, Hitay Özbay,*
11:10-11:30 **Receding Horizon Control and Reduced-Order Methods**, *Ito Kazufumi*
11:30-11:50 **Some Problems of Control for Nonlinear Partial Differential Equations**, *David Russell*
11:50-12:10 **Global Stabilization of Systems of Partial Differential Equations Using Finite Dimensional Controllers**, *Igor Mezic*
12:10-12:30 **Ouput Regulation of Nonlinear Systems with State Delay**, *Emilia Fridman*

Room: 129, Session: FA3

Chair: Wolfgang Kliemann
Title: **Stochastic Control and Estimation**

10:30-10:50 **Algebraic Optimization Techniques for the Estimation of Zero-Beta Pricing Models**, *Bernard Hanzon*
10:50-11:10 **Trajectory Planning Under a Stochastic Uncertainty**, *Ulf Jönsson, Clyde Martin, Yishao Zhou*
11:10-11:30 **An Addendum to the Problem of Stochastic Observability**, *Vasile Dragan, Teodor Morozan*
11:30-11:50 **Combined Optimization of Portfolio and Risk Exposure of an Insurance Company**, *Daniel Cajueiro, Takashi Yoneyama*
11:50-12:10 **On a Unitary Model for Two-Time Parameter Stationary Processes**, *Dan Emanuel Popovici*

Room: 138, Session: FA4

Chair: Patrick Dewilde
Title: **Stability and Numerics**

10:30-10:50 **Parameter Dependent Extremal Norms for Linear Parameter Varying Systems**, *Fabian Wirth*
10:50-11:10 **On the Sensitivity of Algebraic Riccati Equations**, *Ji-guang Sun*
11:10-11:30 **A Numerically Reliable Method for a Neglected but Unsolved Problem: State Feedback Decoupling with Stability for (A, B, C, D) Quadruples**, *Delin Chu*
11:30-11:50 **Large Stability Property of Solutions of Large-Scale Discrete-Time Systems**, *Tanya Lukyanova, Anatoliy Martynyuk*
11:50-12:10 **Pole Placement Under Output Feedback: A Simplification of the Problem**, *Michael Schilmoeller, Joyce O'Halloran*
12:10-12:30 **To the Problem of Construction of Liapunov Functions for Continuous Large Scale Systems**, *Vitaliy Slyn'ko, Anatoliy Martynyuk*

Room: 208, Session: FA5

Chair: Harry Trentelman
Title: **A Behavioral Approach to Systems, Control and Coding Theory**

10:30-10:50 **A Behavioral Approach to List Decoding**, *Jan Willem Polderman, Margreta Kuijper*
10:55-11:15 **Linear Hamiltonian systems**, *Paolo Rapisarda, H.L. Trentelman*
11:20-11:40 **Approximate Time-Controllability versus Time-Controllability**, *Amol Sasane, M.K. Çamlibel*
11:45:12:05 **On a Class of Time-Varying Behaviors**, *Madhu Belur, M.K. Çamlibel, A.J. Sasane, J.C. Willems*
12:10-12:30 **Synthesis of Strictly Dissipative Systems and the Strictly Suboptimal State Space H-infinity Control Problem**, *Harry. L. Trentelman*

Room: 209, Session: FA6

Chair: Naomi Leonard
Title: **Coordinated Control of Vehicle Networks**

10:30-10:50 **Stability of Systems of Self-Driven Particles Undergoing Phase Transitions**, *A. Stephen Morse*
10:50-11:10 **Stability Properties of Interconnected Vehicles**, *Vijay Kumar, Herbert Tanner, George Pappas*
11:10-11:30 **Formations with a Mission: Stable Coordination of Vehicle Group Maneuvers**, *Naomi Leonard, Petter Ogren, Edward Fiorelli*
11:30-11:50 **Coordinated Control Strategies for Networked Vehicles: An Application to Autonomous Underwater Vehicles**, *Joao Sousa, Fernando Pereira*
11:50-12:10 **Group Shape Feedback Control**, *Raffaello D'Andrea*
12:10-12:30 **Hamiltonian Structures for Interacting Satellites**, *P.S. Krishnaprasad*

Room: 210, Session: FA7

Chair: Mrdjan Jankovic
Title: **Nonlinear Control and Applications**

10:30-11:00 **Application of Nonlinear Lyapunov-based Controllers and Observers to Gasoline Direct Injection Engine Charge and Torque Control**, *Ilya Kolmanovsky*
11:00-11:30 **Multivariable Extremum Seeking Feedback: Analysis and Design**, *Kartik B. Ariyur, Miroslav Krstic*
11:30-12:00 **Stabilization of Sets Parametrized by a Single Variable: Application to Ship Maneuvering**, *Roger Skjetne, Andrew R. Teel, Petar V. Kokotovic*
12:00-12:30 **Nonlinear Control and Automotive Engine Applications**, *Mrdjan Jankovic*

Middle:

Room: 102, Session: FM1

Chair: Martin Haenggi
Title: **Mathematical Theory of Networks and Circuits**

14:00-14:20 **On Switched Hamiltonian Systems**, *Arjan van der Schaft, Maurice Heemels, Karin Gerritsen*
14:20-14:40 **Parameter Influence on the Zeros of Network Determinants**, *Sven Feldmann*
14:40-15:00 **Canonical Realizations of Linear Time-Varying Systems**, *Fred Neerhoff, P. van der Kloet*
15:00-15:20 **In Search of Sensitivity in Network Optimization**, *Mike Chen, Charuhas Pandit, Sean Meyn*
15:20-15:40 **Dynamic Eigenvalues for Scalar Linear Time-Varying Systems**, *Pieter Van der Kloet, F.L. Neerhoff*
15:40-16:00 **Interconnection Structures in Physical Systems: a Mathematical Formulation**, *Goran Golo, Orest V. Iftime, Arjan van der Schaft*

Room: 126, Session: FM2

Chair: Belinda King, Kirsten Morris
Title: **Distributed Parameter Systems: Applications and Computation, Part I**

14:00-14:30 **Performance Enhancement of Controlled Diffusion Processes by Moving Actuators**, *Michael Demetriou, Nikolaos Kazantzis*
14:30-15:00 **Equilibrium Profiles of Tubular Reactor Nonlinear Models**, *M. Laabissi, M. E. Achhab,Joseph Winkin, D. Dochain*
15:00-15:30 **Control of Electronic Material**, *Katherine Kime*
15:30-16:00 **Active Sound Field Attenuation via Acoustic Arrays**, *H.T. Banks*

Room: 129, Session: FM3

Chair: William Helton
Title: **Operator Theoretic Methods**

14:00-14:20 **A Nehari Theorem for Continuous-Time FIR Systems**, *Gjerrit Meinsma, Mirkin, Zhong*
14:25-14:45 **Optimal Approximation of Linear Operators: a Singular Value Decomposition Approach**, *Siep Weiland, Hardy Siahaan, Anton Stoorvogel*
14:50-15:10 **Geometrical and Spectral Properties of the Time-Varying Riccati Difference Equation**, *Nevio Carpanese*
15:15-15:35 **A Generalization of the Widrow's Quantization Theorem**, *Alexandru Isar, Dorina Isar*
15:40-16:00 **Functions of System and Their Perturbations**, *Alexey (Olexiy) Tikhonov*

Room: 138, Session: FM4

Chair: David Nicholls
Title: **Nonlinear Surface Water Waves: Theory, Computation and Experiment**

14:00-14:30 **Numerical Simulation of Blow-up Solutions of the Vector Nonlinear Schrödinger Equation**, *Catherine Sulem*
14:30-15:00 **Existence Theory for Traveling Water Waves in Three Dimensions**, *Walter Craig*

15:00-15:30 **Numerical Simulation of Traveling Water Waves**, *David Nicholls*

15:30-16:00 **Similarities between the Quasi-Bubble and the Generalized Wave Continuity Equation Solutions to the Shallow Water Equations**, *John H.Atkinson, Joannes Westerink*

Room: 210, Session: FM5

Chair: Lars Gruene, Fabian Wirth
Title: **Input-to-State Stability, Part II**

14:00-14:30 **Input-to-state stability of pulse width modulated control systems**, *Andrew Teel, L. Moreau, D. Nesic*

14:30-15:00 **ISS for Dynamic Inputs**, *Fabian Wirth*

15:00-15:30 **A Relaxation Theorem for Differential Inclusions with Applications to Stability Properties**, *Yuan Wang, Eduardo Sontag, B. Ingalls*

15:30-16:00 **Characterization of the Non-Uniform in Time ISS Property and Applications**, *Iasson Karafyllis, J. Tsinias*

Room: 126, Session: FP2

Chair: Belinda King, Ruth Curtain
Title: **Distributed Parameter Systems: Applications and Computation, Part II**

16:30-16:50 **POD Based Control of Beam Vibrations: Methodology and Experimental Implementations**, *Brian Lewis, Gregory P. Hicks*

16:50-17:10 **A Comparison of Balancing Techniques for Reduced Order Controllers for Systems of PDEs**, *Belinda King, Katie A. E. Camp*

17:10-17:30 **Modeling and Control Issues Associated with Atomic Force Microscopy**, *Ralph Smith*

17:30-17:50 **The Effect on Control Design of a Stabilized Finite Element Approximation for Burgers' Equation**, *Belinda King,*

17:50-18:10 **Functional Gain Computations for a 1D Parabolic Equation Using Non-Uniform Meshes.**, *John Burns, Belinda B. King, Lizette Zietsman*

18:10-18:30 **A Continuous Control Design Method**, *Jeff Borggaard*

18:00—20:00 Farewell Party

Center for Continuing Education

Abstracts of Presented Talks

Monday August 12, 2002

8:30-9:30 *Room*: 101 Plenary Talk

Bruce Hajek (University of Illinois)

A Basket of System Theoretic Problems in Communications

Researchers are currently faced with a rich set of problems in the design and analysis of wireless communication systems and high-speed communication networks. The purpose of this talk is to survey several significant open problems which system theory could play a role in solving. The problems include: (a) Providing delay constraints in a large communication network in a distributed way, using delay calculus based on the max-plus algebra, (b) Finding the capacity of cellular networks (will survey the recent use of the theory of large random matrices and related free probability theory), (c) Predicting efficiency and fairness, and designing allocation mechanisms, for the Internet, as thousands of autonomous systems interact through self-interested pricing and congestion, and (d) Distributing limited routing information in a large amorphous network, such as a peer-to-peer network or ad hoc sensor array, to facilitate position location.

9:30-10:30 *Room*: 101 Invited Talk

Roger Brockett (Harvard University)

Optimal System Identification for NMR Applications

In a wide variety of settings, the measurement of nuclear magnetic resonance (NMR) effects has proven to be a remarkably effective for investigating unknown structures on both large and small scales. Over the years a large body of technique has been developed for improving the sensitivity and resolution of NMR measurements and many recent advances in biochemistry and medicine are dependent on the sophisticated signal processing techniques now used routinely. From a system theoretic perspective, problems in this area can be thought of as identification problems involving bilinear systems. They are distinguished from linear system identification problems by the fact that the quality of the identification is strongly dependent upon the form of the excitatory input applied to the system. Many ingenious techniques, such as the "two dimensional" Fourier transform procedure have been developed based on particular types of input patterns. Because of the low signal to noise ratios inherent in NMR, the optimization of such methods requires the use of stochastic models for the dynamics and measurement processes. In this talk we take a fresh look at problems in this area with a view toward finding computational procedures that will determine the inputs which will optimize specific performance measures. In particular, we explore performance measures related to conditional entropy, and in this way develop a formalism for establishing the mathematical limits on what can be accomplished with better input design.

9:30-10:30 *Room*: 102 Invited Talk

Hans-Andrea Loeliger (ETH)

Factor Graphs, Least Squares and Kalman Filtering

Factor graphs are graphical models with origins in coding theory and with close relations to Willems-type behavioral system theory. The sum(mary)-product algorithm, which operates by message passing in the factor graph, subsumes a great variety of algorithms in coding, signal processing, and artificial intelligence. In this talk, we apply Forney-style factor graphs to linear models with quadratic cost functions and we show how general versions of Kalman filtering and recursive least squares algorithms arise as instances of the sum-product algorithm. (An "isomorphism" of such factor graphs with electrical networks is presented in a separate talk.)

9:30-10:30 *Room*: 136 Invited Talk

Sjoerd Verduyn Lunel (University of Leiden)

Control and Stabilization of Systems with Time Delays

For dynamical systems governed by feedback laws, time delays arise naturally in the feedback loop to represent effects due to communication, transmission, transportation or tern effects. The introduction of time delays in a system of differential equations results in an infinite dimensional state space. In this paper we give an overview of the basic theory and discuss recent developments concerning the control and stabilization of systems with delays.

Morning:

Room: 102, Session: MA1

Chair: Shmuel Friedland, Brian Marcus
Title: **Capacity of Multi-Dimensional Codes Part I**

11:00-13:00 **Minicourse on "Capacity of Multi-dimensional Codes"**,
Shmuel Friedland (University of Illinois at Chicago)
A multi-dimensional code (mdc) is a filling of points with integer coordinates (lattice) in the d dimensional space with a given alphabet according to some rule. Example: put in any point of the lattice either 0 or 1, with the condition that any 1 must be surrounded by zeros. In this talk we review the available techniques to compute the capacity (density) of mdc.

Room: 126, Session: MA2

Chair: Michael D. Lemmon
Title: **Control Applications**

11:00-11:20 **Cancer Treatment Using Multiple Chemotherapeutic Agents Subject to Drug Resistance**,
John Westman (UCLA),
Bruce Fabijonas (Southern Methodist University),
Daniel Kern (University of Minnesota),
Floyd Hanson (University of Illinois at Chicago)
A compartment model for the evolution of cancer subject to multiple chemotherapeutic agents is presented. The formulation accounts for the heterogeneous nature of cancer and drug resistance, leading to a system that can be used as a tool for optimizing treatments. Chemotherapeutic or cytotoxic agents have limited effectiveness due to of toxicity and the development of drug resistance. Toxicity limits the amount of the agent that can be used and acts as an upper bound on the dosage. Drug resistance causes the clinical value of the cytotoxic agent to become nominal after a small number of treatments. Therefore, several non-cross resistant cytotoxic agents are used to extend the number of treatments that can be administered.

11:25-11:45 **Selection of Decentralized Control Configurations Based on Disturbance Rejection for Plants with Real Integrators**,
Henning Schmidt, Elling Jacobson
(KTH)
The paper considers the effect of interactions on the disturbance rejection properties of decentralized control systems. In particular, the problem of selecting the control structure yielding the best disturbance rejection under independent tuning of the individual subsystems is addressed. As a special case we consider systems that contain one or more integrators and which give rise to a number of zero elements in the transfer-matrix of the overall system.

11:50-12:10 **Synergetic Control of the Unstable Two-Mass System**,
Alexander Kolesnikov (Taganrod State University, Russia)
The paper is devoted to a problem of synergetic regulators synthesis for nonlinear unstable two-mass system "inverted pendulum". The different variants of synergetic regulators synthesis for this system are presented. Synthesized regulators are constructed on basis of nonlinear mathematical models. The synthesized regulators allow not only to solve the pendulum stabilization task at the top unstable position but also form the new modes of dynamic behavior such as autooscillations of the pendulum and the cart around the set position

12:15-12:35 **Synergetic Control for Electromechanical Systems**,
Andrey Popov, Anatoly Kolesnikov, Gennady Veselov, Alexander Kolesnikov (Taganrod State University, Russia);
Roger Dougal (University of South Carolina)
The paper is devoted to a problem of synergetic regulators synthesis for nonlinear electromechanical systems (EMS). The different variants of synergetic regulators synthesis for such EMS as DC electric drives, asynchronous electric drives and synchronous electric drives are presented. Synthesized vector regulators are constructed on basis of nonlinear mathematical models and ensure to perform the standard technological tasks: angle and angular speed stabilization, torque stabilization etc. Also examples of EMS using in mechanical oscillator mode and the task of EMS's power-saving control are considered.

12:40-13:00 **Modeling of Out-of-Plane Hygroinstability of Multi-Ply Paperboard**,
Gianantonio Bortolin, Per-Olof Gutman (KTH);
Bengt Nilsson
This paper describes a semi-physical model for the dimensional stability properties (i.e. curl) of the carton board produced at AssiDomn Frvi, Sweden. The main equations are based on classical lamination theory of composite materials, and each constituent ply is considered as a macroscopic homogeneous, elastic medium. The model shows a general agreement between predicted and measured curvatures.

Room: 136, Session: MA4

Chair: Bill Helton, Andre Ran, Leiba Rodman
Title: **Matrix and Operator Equations I**

11:00-11:30 **Noncanonical Almost Periodic Factorization and Toeplitz Operators with Almost Periodic Symbols**,
Leiba Rodman, I. M. Spitkovsky, H. J. Woerdeman (College of William and Mary)
Noncanonical factorizations of almost periodic matrix valued functions of several real variables are studied. In particular, results are proved on behavior of factorization indices under small perturbations, connections between left and right indices, and relations between factorization and Fredholmness properties of the associated Toeplitz operators.

11:30-12:00 **Symmetric Nonsquare Factorization of Selfadjoint Rational Matrix Functions and Algebraic Riccati Inequalities**,
A. C. M. Ran Mark A. Petersen (Vrije Universiteit, Amsterdam)
In this talk we shall present a parametrization of all symmetric, possibly nonsquare minimal factorizations of a positive semidefinite rational matrix function. It turns out that a pole-pair of such a nonsquare factor is the same as a pole pair for a specific square factor. The location of the zeros In this talk we present a parametrization of all symmetric, possibly nonsquare minimal factorizations of a positive semidefinite rational matrix function. It turns out that a pole-pair of such a factor is the same as a pole pair for a specific square factor. The location of the zeros is determined by a solution to a certain algebraic Riccati inequality. We also consider the case where the function has constant signature. A connection with Bezoutians is discussed.

12:00-12:30 **Extremal Problems of Interpolation Theory**,
L. A. Sakhnovich
We consider interpolation problems the solutions of which satisfy in addition an extremal condition.We show that under some assumptions the extremal interpolation problem has a unique solution.We compare our approach with optimal and superoptimal approaches. The results of our talk were obtained jointly with J.W.Helton.

12:30-13:00 **Convex Invertible Cones, Nevalinna-Pick Interpolation and the Set of Lyapunov Solutions**,
Izchak Lewkowicz, Nir Cohen (Ben-Gurion University of the Negev)
For a real matrix A whose spectrum avoids the imaginary axis, it is shown that the three following, seemingly independent problems, are in fact equivalent. Characterizing the set of real symmetric solutions of the algebraic Lyapunov inclusion associated with A. The image of all Nevalinna-Pick interpolations associated with the spectrum of A. The structure of the Convex Invertible Cone generated by A.

Room: 208, Session: MA5

Chair: Lorenzo Farina, Maria Elena Valcher
Title: **Positive Systems**

11:00-11:30 **Positive Systems in the State Space Approach: Main Issues and Recent Results**,
Lorenzo Farina (Università di Roma "La Sapienza")
A positive system is a system in which the state variables are always positive in value. In this introductory tutorial paper, basic results on positive systems are reviewed and recent developments and open problems are addressed.

11:30-12:00 **Positive Systems in the Behavioral Approach: Main Issues and Recent Results**,
Maria Elena Valcher (University of Padova)
The aim of this paper is to provide an overview of the most significant results about positive systems, obtained within the behavioral approach, and, specifically the main results about positive autonomous behaviors, and to present some new results concerned with the positive realization problem for controllable behaviors.

12:00-12:30 **Feedback Stabilisation with Positive Control of Dissipative Compartmental Systems**,
Georges Bastin, A. Provost (Universite' Catholique de Louvain)
In many process control applications, the system under consideration is compartmental and positive. For such systems, the design of state feedback controllers makes sense only if the control function is guaranteed to provide a non-negative value at any time instant. The purpose of this paper is to present a positive control law for the feedback stabilisation of positive compartmental systems which are dissipative but can nevertheless be globally unstable. The approach is illustrated with an application to an industrial grinding circuit.

12:30-13:00 **Feedback Control for a Chemostat with two Organisms**,
Patrick De Leenheer, Hal Smith
(Arizona State University)
It is shown that a chemostat with two organisms can be made coexistent by means of feedback control of the dilution rate.

Room: 209, Session: MA6

Chair: Augusto Ferrante, Michele Pavon
Title: **Control of Quantum Mechanical Systems**

11:00-11:30 **Sufficient Conditions for Controllability of Finite Level Quantum Systems via Structure Theory of Semisimple Lie Algebras**,
Claudio Altafini (ISAS, Italy)
The controllability of the unitary propagator of a finite level quantum system is studied in this paper by analyzing the structure of the semisimple Lie algebra $su(N)$.

11:30-12:00 **Geometric Control of Quantum Mechanical Systems in a Noisy Environment**,
Domenico D'Alessandro (Iowa State University)
We study the control problem for a general (finite dimensional) quantum system interacting with a bath. In the Hamiltonian formulation, the overall (System plus Environment) system varies on a Hilbert space which is the tensor product of the system and environment Hilbert spaces. We use sensitivity functions as a tool to compare control laws and trajectories in this formulation. We treat the example of a spin 1/2 particle in a spin bath in detail. For this system, using optimal control theory and first order sensitivity as the cost, we explicitly derive the minimum decoherence controls.

12:00-12:30 **Control of Quantum Systems Using Model-based Feedback Strategies**,
Augusto Ferrante, Michele Pavon
(Università di Padova);
Giorgio Raccanelli
Coherent control of quantum-mechanical systems is a growing field due to recent advances in laser technology and to the miniaturization of electronic devices. We present in this paper a new approach to this problem. We consider feedback control strategies for the Schroedinger equation of a multilevel quantum system that eventually produce the decrease of the distance between the state (or the propagator) and the target. Once the functional form of these controls has been obtained, plugging them into the evolution equation we get a nonlinear initial value problem. When the nonlinear problem can be numerically solved, we can construct explicitly the control functions and then implement them in open-loop to achieve the desired transfer.

12:30-13:00 **Quantum Control of Dissipative Systems**,
Sonia G. Schirmer, A. I. Solomon
(The Open University, Milton Keynes)
We study the effect of dissipation on one's ability to control a quantum system. In particular, we show that dissipation, although often considered undesirable, opens new possibilities for quantum control by removing the constraint of unitary evolution, which restricts the set of reachable sets and imposes bounds on the optimization of observables.

Room: 210, Session: MA7

Chair: Peter Bauer
Title: **Adaptive Control**

11:00-11:20 **Gap Metric Robustness of Adaptive Controllers**,
Mark French (University of Southampton)
We consider the construction of adaptive controllers for minimum phase linear systems which achieve nonzero robustness margins in the sense of the (linear) L^2 gap metric. The gap perturbations may be more constrained for larger disturbances and for larger parametric uncertainty. Working within the framework of the nonlinear gap metric due to Georgiou and Smith, universal adaptive controllers are first given achieving this goal for first order plants, and the results are then generalised to relative degree one, minimum phase plants.

11:20-11:40 **Adaptive Predictive Control with Controllers of Restricted Structure**,
Michael Grimble, Peter Martin
(University of Strathclyde)
A novel adaptive predictive optimal controller of low order, involving a multi-step cost index and future setpoint knowledge, is considered. A non-linear system, represented by a set of multiple linear discrete-time state-space models plus one identified model is to be controlled. Simulation results applied to a ship roll example demonstrate that the controller is more robust than a standard self-tuning scheme, but is capable of good performance.

11:40-12:00 **Output Adaptive Model Reference Control of Linear Continuous State-Delay Plant**,
Boris Mirkin, Per-Olof Gutman
(Technion - Israel Institute of Technology)
This paper develops a new approach for the output model reference adaptive control of linear continuous-time plants with state delays. The main idea is to include into the control law a feedforward component which compensates for the delayed states, in addition to output feedback. The feedforward is formed by special adaptively adjusted prefilters as a function of the delayed state of the reference model. The output feedback component is designed as for a plant without delay, but applied to the time-delay plant. Such a controller structure containing adaptive output error feedback and adaptive prefilters from the delayed reference model makes it possible to solve the problem of adaptive exact asymptotic output tracking under parametric uncertainties. The stability is analyzed using the Lyapunov-Krasovskii functional method. Simulation results show the effectiveness of the proposed scheme.

12:00-12:20 **A Comparison Between Robust Adaptive Controllers w.r.t a Non–singular Transient Cost**,
Ahmad Sanei, Mark French
(University of Southampton)
A nonsingular performance comparison between two standard robust adaptive control designs based on the dead-zone and projection modifications is given. A worst case transient cost functional penalising the L-infinity norm of the state, control and control derivative has been chosen as the criterion of comparison. If a bound on the L-infinity norm of the disturbance is known, it is shown that the dead-zone controller outperforms the projection controller when the a-priori information on the unknown system parameter is sufficiently conservative. For clarity of the presentation, the result is restricted to scalar systems and the generalisations are only briefly discussed.

12:20-12:40 **A Manifold Structure on the set of Functional Observers**,
Jochen Trumpf, Uwe Helmke
(Universität Würzburg)
Assume, a linear function f of the state x of a linear control system in state space form is given. An observer for this function is another linear control system taking the input and the output of the observed system as its input and generating from it an estimate for f. The observer is called a tracking observer if its state z satisfies the tracking property: whenever the observer is started with an exact estimate $z(0) = f(x(0))$ it will continue to produce an exact estimate $z(t) = f(x(t))$ for all future times t. It is well known that a tracking observer for f exists if and only if the kernel of f is a conditioned invariant subspace with respect to the observed system. The set M of tracking observer parameters of fixed size, i.e. tracking observers of fixed order together with the functions they are tracking, is shown to be a smooth manifold. Furthermore, the set of conditioned invariant subspaces of fixed codimension together with their friends, i.e. the output injections making the subspace invariant, is shown to carry a vector bundle structure over M. Potential applications are in the area of pole placement by dynamic output feedback as well as the analysis of the convergence behaviour of numerical algorithms for observer design.

Middle:

Room: 102, Session: MM1

Chair: Shmuel Friedland, Brian Marcus
Title: **Capacity of Multi-Dimensional Codes Part II**

14:00-15:00 **On the Capacity of 2-D Constrained Codes and Consequences for Full-Surface Data Channels**,
William Weeks (University of Missouri–Rolla)
The capacity of two-dimensional constrained binary codes is bounded by considering strips in the plane of width n and constructing matrix recursions. Curve-fitting and bounding techniques allowe precise estimates of the capacity to be made. Finally, by assuming that capacity-achieving encoders and decoders exist, density improvements for full-surface channels are calculated, and those calculations verified by numerical simulation.

15:00-16:00 **Counting Independent Sets in the Grid, And Similar Questions**,
Neil Calkin (Clemson)
We shall consider various enumeration questions arising from statistical mechanics: for example, counting the number of independent sets in an $n \times k$ grid, counting non-attacking configurations of Kings on an $n \times k$ chessboard, etc. We shall show how to prove rigorous (albeit somewhat weak) upper and lower bounds on the entropy of such systems. We will also introduce a formulation which leads to many open questions about the eigenstructure of recursively defined matrices.

Room: 126, Session: MM2

Chair: Wei Lin
Title: **Nonlinear Systems and Control 1**

14:00-14:20 **Estimating Generalized Gradients of Value Function in Optimal Control Problems for Differential-Difference Inclusions**,
Leonid Minchenko, Aleksey Volosevich
(Belarus State University)
This paper deals with the optimal control problems for the differential- difference inclusions under endpoint constraints. The result obtained employs Clarke's normal cones and the estimates of generalized gradients of the value function. The method for estimating generalized gradients is developed. These estimates are used for obtaining necessary optimality conditions.

14:20-14:40 **Interconnected Systems of Fliess Operators**,
W. Steven Gray, Yaqin Li
(Old Dominion University)
Given two analytic nonlinear input-output systems represented as Fliess operators, four system interconnections are considered in a unified setting: the parallel connection, product connection, cascade connection and feedback connection. In each case, the corresponding generating series is produced, when one exists, and conditions for convergence of the corresponding Fliess operator are given. In the process, an existing notion of a composition product for formal power series is generalized to the multivariable setting, and its set of known properties is expanded. In addition, the notion of a feedback product for formal power series is introduced and characterized.

14:40-15:00 **Controllability Analysis of A Two Degree of Freedom Nonlinear Attitude Control System**,
Jinglai Shen, Amit K. Sanyal, N. Harris McClamroch
(The University of Michigan)
We study a physically simple two degree of freedom attitude control system that has a single control input. The physical assumptions are described. Equations of motion are derived and expressed in a nonlinear control form. We demonstrate that the system is inherently nonlinear. Conditions for small time local controllability of the state and of the configuration are presented.

15:00-15:20 **Sliding Mode Idle Speed Ignition Control Strategies for Automotive Engines**,
Manjit Singh Srai
(U of Central England in Birmingham),
H. Sindano (Sagem-Johnson, Birmingham),
N. E. Gough (University of Wolverhampton)
, A. C. Cole (U of Central England in Birmingham)
A potentially improved class of systems involves sliding mode control, in which the actuating signal is changed discontinuously, depending on the position of the system trajectory in state space, forces the state trajectory to track a defined hyperplane towards the desired steady-state. This affords the opportunity of simplifying the complex and uncertain processes that occur within SI engines and to develop new methods of controlling their performance.

15:20-15:40 **Truncation and Approximation Errors in the Max-Plus Algorithm for H-infinity Control**,
William McEneaney
(University of California, San Diego)
We consider the H-infinity problem for a nonlinear system. The semi-group is linear over the max-plus algebra. The value function is an eigenfunction corresponding to the max-plus multiplicative identity. One may truncate an expansion to obtain a finite-dimensional problem. We obtain some error estimates for the size of the errors introduced by this basis truncation, and consider errors introduced by the approximation of the elements of the matrix.

15:40-16:00 **Solution of Second Order Linearization**,
Rajagopalan Devanathan
(Nanyang Technological University, Singapore)
For a nonlinear system with a control input, a generalized form of the homological equation can be formulated to reduce the system to its normal form. In this paper, it has been shown that for a linearly controllable system with an appropriate choice of state feedback, the generalized homological equation can be solved to give an explicit solution, of a reduced order, to the problem of second order linearization.

Room: 129, Session: MM3

Chair: Giorgio Picci, Augusto Ferrante
Title: **Stochastic Systems 1**

14:00-14:30 **Canonical Correlations Between Input and Output Processes of Linear Stochastic Models**,
Katrien De Cock, Bart De Moor
(Université Catholique de Louvain)
We obtain expressions for the principal angles between the row spaces of input and output data block Hankel matrices of a linear stochastic model in terms of the model parameters. The canonical correlations of the corresponding processes are equal to the limiting val-

ues of the cosines of the principal angles. From these parametric expressions, the relations between the different sets of canonical correlations can be easily deduced.

14:30-15:00 **A Regularized Cepstrum and Covariance Matching Method for ARMA(n,m) Design**,
Per Enquist(LADSEB/CNR Padova, Italy)
An ARMA(n,m) model is uniquely determined by its n first covariances and m first cepstrum coefficients. However, there does not always exist a model matching an estimated set of these parameters. We propose a method determining an asymptotically stable minimum phase model that match the covariances exactly and the cepstrum parameters approximatively. A convex barrier term is used for regularization and the model is determined by a convex optimization problem.

15:00-15:30 **On Some Interpolation Problems**,
György Michaletzky
(Eötvös LoràND University, Budapest),
A. Gombani (LADSEB-CNR Padova, Italy)
Some aspect of the partial realization problem formulated for Schur-functions considered on the right half plane is investigated. We show among others that in the linear fractional parameterization of all solutions the condition on the McMillan-degree of the solution is transformed into an interpolatiom condition. This analysis can be considered to be partially complementary to the results of A. Lindquist, C. Byrnes et al. on Carathodory functions.

15:30-16:00 **Non-regular Processes and Singular Kalman Filtering**,
Augusto Ferrante, Stefano Pinzoni, Giorgio Picci
(Università di Padova)
Contrary to the continuous-time case, a discrete-time process y can be represented by minimal linear models, which may either have a non-singular or a singular D matrix. In fact, models with D=0 have been commonly used in the statistical literature. On the other hand, for models with a singular D matrix the Riccati difference equation of Kalman filtering involves in general the pseudo-inversion of a singular matrix. This "cheap filtering" problem has been studied for several decades in connection with the so-called "invariant directions" of the Riccati equation. For a singular D, a reduction in the order of the Riccati equation is in general possible. In this paper, we provide an explanation of this phenomenon from the classical point of view of "zero flippin" among minimal spectral factors. Changing D's occurs whenever zeros are "flipped" from $z = \infty$ to their reciprocals at $z = 0$. It is well known that for finite zeros the zero-flipping process takes place by multiplication of the underlying spectral factor by a suitable rational all-pass matrix function. For infinite zeros, zero-flipping is implemented by a dual version of the Silverman structure algorithm. Using this interpretation, we derive a new algorithm for filtering of non-regular processes, based on a reduced-order Riccati equation.

Room: 136, Session: MM4

Chair: I. Gohberg, M.A. Kaashoek
Title: **State Space Methods for Problems in Operator Theory**

14:00-14:30 **State Space Methods, Reproducing Kernel Spaces and Applications**,
Harry Dym (The Weizmann Institute)
There is a natural connection between finite dimensional reproducing kernel Hilbert and Krein spaces and state space theory which underlies many problems that have been investigated in the last several years. The purpose of this talk is to explain this connection and illustrate it by means of examples drawn largely from problems of interpolation, extension and factorization, as time permits. The talk will be expository.

14:30-15:00 **A Beurling–Lax Type Theorem in the Unit Ball**,
Daniel Alpay, Aad Dijksma, Jim Rovnyak
(Ben-Gurion University of the Negev)
Schur multipliers on the unit ball are operator-valued functions for which the N-variable Schwarz-Pick kernel is nonnegative. In this paper, the coefficient spaces are assumed to be Pontryagin spaces having the same negative index. The associated reproducing kernel Hilbert spaces are characterized in terms of generalized difference-quotient transformations.

15:00-15:30 **A Naimark Dilation Perspective on Positive Real Interpolation**,
A. Frazho (Purdue University)
No Abstract
15:30-16:00 **State Space Method, Explicit Solutions of Scattering Problems, and Nonlinear Integrable Equations**,
Alexander L. Sakhnovich
We review recent results on the canonical differential systems with the pseudo-exponential potentials (and related nonlinear integrable equations) that involve applications of state space techniques. Such sys-

tems are characterized by the requirement that the associated Weyl function is a bi-proper positive-real stable rational matrix function. Explicit formulas for the fundamental solution, the spectral and scattering functions and bound states are derived.

Room: 208, Session: MM5

Chair: Xiaochang Wang
Title: **Output Feedback Control of Linear Systems**

14:00-14:30 **Counterexamples to Pole Placement by Real Static Output Feedback**,
Alex Eremenko, A. Gabrielov
(Purdue University)
We consider linear systems with m inputs, p outputs and McMillan degree n controlled by static output feedback with a gain matrix K. The pole placement map for such system is given by

$$\begin{aligned} \mathrm{Mat}_{\mathbf{R}}(m \times p) &\to \mathrm{Poly}_{\mathbf{R}}(mp), \\ K &\mapsto \psi_K = \det(\lambda I - A - BKC), \end{aligned}$$

where $A \in \mathrm{Mat}_{\mathbf{R}}(n \times n)$, $B \in \mathrm{Mat}_{\mathbf{R}}(n \times m)$ and $C \in \mathrm{Mat}_{\mathbf{R}}(p \times n)$ are real matrices, and $\mathrm{Poly}_{\mathbf{R}}(mp)$ is the set of monic polynomials of λ of degree mp with real coefficients.
We say that for a given triple of integers (m, n, p) the pole placement map is generically surjective if there is a dense open set of systems $(A, B, C) \in \mathrm{Mat}_{\mathbf{R}}(n \times n) \times \mathrm{Mat}_{\mathbf{R}}(n \times m) \times \mathrm{Mat}_{\mathbf{R}}(p \times n)$ such that the image of the map (**??**) contains an open dense subset of $\mathrm{Poly}_{\mathbf{R}}(mn)$.
It was known that $mp \geq n$ is necessary and mpn is sufficient for generic surjectivity. It was also known that the real pole placement map is not generically surjective for $(m, p) = (2, 2)$ and $(2, 4)$. We extend this result:
THEOREM. For every pair (m, p) of even integers, there exists an open set U of systems $S = (A, B, C)$ with m inputs, p outputs and McMillan degree mp, such that for every $S \in U$ the real pole placement map (1) omits an open set in $\mathrm{Poly}_{\mathbf{R}}(mp)$.
The open set U in this theorem is a neighborhood of a system S_0 defined by a rational curve in the Grassmannian $G(m, m + p)$ which osculates the normal rational curve in the projective space $\mathbf{RP}^{m+p-1}$. The omitted subset in $\mathrm{Poly}_{\mathbf{R}}(mp)$ is a neighborhood of a set of polynomials whose zeros belong to a circle orthogonal to the real line.

14:30-15:00 **Numerical Homotopy Algorithms for Satellite Trajectory Control by Pole Placement**,
Jan Verschelde, Yusong Wang
(University of Illinois at Chicago)
The aim of this paper is to illustrate the application of numerical homotopy algorithms to control the trajectory of a satellite. We design output feedback laws via pole placement. The output feedback laws are computed by numerical homotopy algorithms, which are based on enumerative geometry. We combine the use of MATLAB with PHCpack.

15:00-15:30 **Numerical Schubert Calculus by the Pieri Homotopy Algorithm**,
Tien-Yien Li, Xiaoshen Wang, Mengnien Wu
(Michigan State University)
Some control theory and enumerative geometry problems can be formulated as follows. Given linear subspaces $L_1, ..., L_n$ (of certain vector space, satisfying certain conditions), find all subspaces of certain dimension which intersect the given subspaces non trivially. We derived a modified Pieri homotopy algorithm for numerically finding all the solutions. In the process, all polynomial systems to be solved are square systems.

15:30-16:00 **On Minimal Order Decentralized Output Feedback Pole Assignment Problems**,
Xiaochang Wang (Texas Tech University)
We give a new sufficient condition for the arbitrary pole assignability of a system by decentralized dynamic compensators. Using such condition we are able to derive a new bound on the degrees of decentralized dynamic compensators so that the generic systems have the arbitrary pole assignability.

Room: 209, Session: MM6

Chair: Yutaka Yamamoto
Title: **Optimization and Optimal Control**

14:00-14:20 **A Jacobi-like Method for the Indefinite Generalized Hermitian Eigenvalue Problem**,
Christian Mehl (Technical University of Berlin)
Indefinite generalized Hermitian eigenvalue problems arise in many applications, for example in the linear quadratic optimal control problem. In this talk, we propose a Jacobi-like algorithm for the solution of the indefinite generalized Hermitian eigenvalue problem and discuss its convergence properties. Moreover, numerical examples will be presented.

14:20-14:40 **Disturbed Discrete Time Linear-Quadratic Open-Loop Nash games**,
Gerhard Jank, Dirk Kremer
(RWTH Aachen)
We examine disturbed linear-quadratic games, where each player chooses his strategy according to a modified Nash equilibrium model under open-loop information structure. We give conditions for the existence and uniqueness of such an equilibrium. We also show how these conditions are related to certain Riccati difference equations and a boundary value problem.

14:40-15:00 **Linear Matrix Inequalities for Global Optimiztion of Rational Functions and H2 Optimal Model Reduction**,
Dorina Jibetean (CWI, Amsterdam),
Bernard Hanzon
In this paper we study unconstrained global optimization of rational functions. We give first few theoretical results and study then a relaxation of the initial problem. The relaxation is solved using LMI techniques. Therefore, in general our procedure will produce a lower bound of the infimum of the original problem. The algorithm is then applied to the H2 optimal model reduction problem.

15:00-15:20 **Newton's Method for Optimization in Jordan Algebras**,
Sandra Ricardo
(University of Tras-os-Montes e Alto Douro,Portugal),
Uwe Helmke, Shintaro Yoshizawa
(University of Würzburg)
We consider a convex optimization problem on linearly constrained cones in a Euclidean Jordan algebra. The cost function consists of a quadratic cost term plus a penalty function. A damped Newton algorithm is proposed for minimization. Quadratic convergence to the global minimum is shown using an explicit step-size selection.

15:20-15:40 **Non-symmetric Riccati Theory and Linear Quadratic Nash Games.**,
Dirk Kremer (RWTH Aachen),
Radu Stefan (University Polytechnica Bucharest)
The existence of a stabilizing solution to the non-symmetric algebraic Riccati equation is shown to be equivalent to the invertibility of a certain Toeplitz operator, whose symbol is the transfer matrix function of an exponentially dichotomic system. We also show that this theory has an important application to non-cooperative differential games.

15:40-16:00 **Some New Results on Linear Quadratic Regulator Design for Lossless Systems**,
Maria Gabriella Xibilia (University of Messina),
Luigi Fortuna, Giovanni Muscato
(University of Catania)
In the paper new results concerning LQR regulator design for lossless systems are proved. In particular it is given a necessary and sufficient condition which allows to obtain the optimal gains of an LQR problem for a lossless system without solving the CARE equation, when a particular quadratic index is considered.

Afternoon:

Room: 102, Session: MP1

Chair: Sandro Zampieri
Title: **The Interaction of Control, Information and Communication**

16:30-16:50 **Minimum Data Rates for Stabilising Linear Systems with Unknown Parameters**,
Girish Nair, Robin J. Evans, Björn Wittenmark
(University of Melbourne)
A fundamental question in the field of joint communication and control is the following: if a plant and controller communicate at a limited data rate and no restrictions but causality are placed on the coding and control policy, what is the smallest rate above which stabilisation is possible? In this talk, the case of discrete-time LTI systems with unknown parameters is discussed. Necessary and sufficient data rate bounds for stabilisability are presented.

16:50-17:10 **A Graphical Model Approach to Distributed Control**,
Sekhar Tatikonda (UC-Berkeley)
We develop a graphical model framework for visualizing structural properties of distributed systems. We show that this graphical model can be used to determine which agents influence other agents. Furthermore it can be used to determine which elements in an agent's information pattern are relevant to its decision. These structural observations suggest approximation techniques.

17:10-17:30 **Quantized Stabilization of Single-input Nonlinear Affine Systems**,
Jialing Liu, Nicola Elia
(Iowa State University)
In this paper we show that, for a single-input nonlinear affine continuous-time system, a (robustly) stabilizing quantizer can be constructed based on a (robust) control Lyapunov function. We characterize

the coarsest quantizer under certain conditions. The quantized control scheme provides understanding to the problem of how much interaction between the controller and the system dynamics is needed for stabilization.

17:30-17:50 **Distributed Robust Controller for Complex Networks**,
Wing Shing Wong (Chinese University of Hong Kong)
Recently, control problems defined over a distributed, complex networking environment have received much attention. Examples of these problems include congestion control over the Internet and the power control problem of a wireless communication system. Controllers for these systems should possess certain characteristics. For example, they should depend only on a small amount of observation data in order to minimize communication overhead. They have to relatively insensitive to the system parameters and maybe even to the system structure, since there are great uncertainties about the system model. Moreover, the decision rules are distributed to a large number of independent players, who may or may not be cooperating. In this talk, we report on some robust convergence results of a common class of distributed, low data rate feedback controllers.

17:50-18:10 **Stabilizing Quantized Feedback with Minimal Information Flow: the Scalar Case**,
Fabio Fagnani (Politecnico di Torino),
Sandro Zampieri (Universitá di Padova)
In the performance analysis of a quantized stabilization strategy, two parameters play a central role: the number of quantization levels used by the feedback and the convergence time of the closed loop system. In this paper we propose a definition of optimality for a quantized stabilization strategy based on how these parameters grow with the contraction, which is the ratio between the measure of the starting region and the target region of the state space. Then, we analyze the performance and prove the optimality of three different stabilizing quantized feedbacks strategy for scalar linear systems. A state feedback with finitely many quantization levels yields only the so called practical stabilization, namely the convergence of any initial state belonging to a bigger bounded region into another smaller target region of the state space. The ratio between the measure of the starting region and the target region is called contraction of the closed loop system.

18:10-18:30 **Systems of Dynamics and their Cohomological Invariants**,
Reuben Rabi, Sanjoy Mitter
(MIT),
This talk introduces the idea that an open nonlinear dynamical system of the affine kind can, when composed of an interacting assembly of subsystems, be viewed "as a space" and demonstrates that this idea has clear and concrete implications for our understanding of the structure of such systems, which has traditionally been a difficult area resisting meaningful progress. We produce invariants of an assembly of interconnected systems which reflect the manner in which the (sub-)systems are interconnected. Our invariants are cohomology groups which are sensitive to dynamics around closed loops of the underlying graph of the system of dynamics.

Room: 126, Session: MP2

Chair: Matthias Kawski
Title: **Nonlinear Systems and Control 2**

16:30-16:50 **Skorokhod-Neumann Boundary Conditions in Robust Queueing Service Models**,
Martin Day (Virginia Tech)
We introduce the idea of boundary extremals in control problems for simple fluid models of queueing systems with Skorokohd dynamics, using an L2-gain robust control formulation. Connections with viscosity-sense Neumann boundary conditions are mentioned. A simple example is presented in which these extremals play a fundamental role in the construction of the optimal strategy.

16:50-17:10 **Optimization Methods for Target Problems of Control**,
Alexander B. Kurzhanski, Pravin Varaiya
(University of California at Berkeley)
The present paper indicates an array of reachability problems relevant for nonstandard target problems of control. The problems are solved through dynamic programming techniques for systems with non-integral costs. This leads to new types of generalized Hamilton-Jacobi-Bellman type equations in the general case and in the linear case allows treatment through duality methods of convex analysis and min-max theory.

17:10-17:30 **On Optimal Quadratic Lyapunov Functions for Polynomial Systems**,
Graziano Chesi (University of Siena),
Alberto Tesi (University of Florence),
Antonio Vicino (University of Siena)
The problem of estimating the domain of attraction of equilibria of polynomial systems is considered. Specifically, the computation of the quadratic Lyapunov function which maximizes the volume of the estimate is addressed. In order to solve this double non-convex optimization problem, a semi-convex approach based on LMIs is proposed. Moreover, for the case of odd polynomial systems, a relaxed criterion for obtaining an effective starting candidate is presented.

17:30-17:50 **The Maximum Principle for an Optimal Solution to a Differential Inclusion with State Constraints**,
Aurelian Cernea (University of Bucharest)
We consider an optimal control problem given by a differential inclusion, whose trajectories are constrained to the closure of an open set. Using recent results on existence and relaxation of solutions of the constrained differential inclusion necessary optimality conditions are obtained in the form of a maximum principle.

17:50-18:10 **Synergetic Synthesis of Nonlinear Interconnected Control for Turbogenerators**,
Anatoly Kolesnikov, Andrew Kuzmenko
(Taganrog State University, Russia)
The analytical synthesis problem of coordinating regulator for power system, consisting of two turbogenerators, working at big power network, is considered in this article. We used nonlinear, non-conservative and interconnected model of such power system. There are four control channels in this case. To solve this hard task we used main approach of synergetic control theory. This approach was developed by professor A.A. Kolesnikov. Briefly synthesis procedure is described. The synthesized regulator provides stabilization of the generators excitation currents (synchronous EMFs), coordinated turbines rotation frequency, asymptotic stability of the closed-loop system in the whole and compensates the external low-frequency harmonic disturbances that act to generators. Example of synthesis is considered.

18:10-18:30 **Stabilities and Controllabilities of Switched Systems (with Applications to the Quantum Systems)**,
Leonid Gurvits (Los Alamos National Laboratory)
We study various stabilities and controllabilities of linear switched systems, including those appearing in the quantum computations context . A number of new results and connections is presented, most of them with proofs .

Room: 129, Session: MP3

Chair: Amarjit Budhiraja
Title: **Stochastic Control and its Applications**

16:30-17:00 **Nonlinear Filtering in Correlated Noise: a Wiener Chaos Approach**,
Sergey Lototsky (USC)
The solution to the Zakai filterling equation for the time homogeneous diffusion filtering problem with correlated noise is approximated using the Galerkin approximation followed by the Wiener Chaos decomposition. The approximation error is estimated and a corresponding numerical algorithm is described. The algorithm has a very simple real-time part and can be used with both continuous and discrete time observations.

17:00-17:30 **Stationary Solutions and Forward Equations for Controlled and Singular Martingale Problems**,
Richard H. Stockbridge
(University of Wisconsin Milwaukee)
Stationary distributions of Markov processes can typically be characterized as probability measures μ that annihilate the generator A of the process; that is, for each such μ, there exists a stationary solution of the martingale problem for A with marginal distribution μ. This result is extended to martingale problems that include absolutely continuous and singular (with respect to time) components and controls. Analogous results for the forward equation follow as a corollary.

17:30-18:00 **An Investment Model with Liquidity Risk**,
Hui Wang
We develop a continuous-time investment model to incorporate the presence of Liquidity risk. It is mathematically equivalent to an optimal stopping problem with multiple entries and forced exits. We obtain the closed-form solution, under the assumptions of geometric Brownian motion output price and Poisson liquidity shocks. It is shown that the liquidity risk is a true sense risk if and only if the entry cost is large enough compared to the running cost.

18:00-18:30 **Mean-Variance Portfolio Selection under Markov Regime: Discrete-time Models and Continuos-time Limits**,
George Yin (Wayne State University),
X. Y. Zhou (Chinese University of Hong Kong)
In this paper, we propose a discrete-time model for mean-variance portfolio selection. One of the distinct features is that the system under consideration is a Markov modulated system. We show that under suitable conditions and scaling, the process of interest goes to a switching diffusion limit. Related issues on optimal strategies and efficient frontier will also be mentioned.

Room: 136, Session: MP4

Chair: Harry Dym, Heinz Langer
Title: **Spaces with Indefinite Metrics and Inverse**

16 :30-17:00 **Regular and Singular Point-like Perturbations of some Differential Operators in Pontryagin Spaces**,
Aad Dijksma (University of Groningen)
Yuri Shondin (Nizhny Novgorod)
The minimal realization of the Bessel differential expression

$$-\frac{d^2}{dx^2}+\frac{\alpha^2-1/4}{x^2},\quad 0\neq\alpha\in(-1,1),$$

in the Hilbert space $L^2((0,\infty);dx)$ is symmetric and has defect numbers $(1,1)$. The Q-function for this symmetric operator and one of its canonical selfadjoint extensions is

$$Q(z)=-\frac{\pi(-z)^\alpha}{2\sin(\pi\alpha)}.$$

The minimal realization of the Laguerre expression

$$-x\frac{d^2}{dx^2}-(1+\alpha-x)\frac{d}{dx}),\quad 0\neq\alpha\in(-1,1),$$

in the Hilbert space $L^2((0,\infty);x^\alpha \mathrm{e}^{-x}dx)$ is symmetric and has defect numbers $(1,1)$. The Q-function for this symmetric operator and one of its canonical selfadjoint extensions is

$$Q(z)=-\frac{\pi}{\sin(\pi\alpha)}\frac{\Gamma(-z)}{\Gamma(-z-\alpha)}.$$

Both functions are classical Nevanlinna functions for $0\neq\alpha\in(-1,1)$, but for all other real noninteger values of α they are generalized Nevanlinna functions, and hence are Q-functions for some symmetric operator in a Pontryagin space with defect numbers $(1,1)$ and one of its canonical selfadjoint extensions. The problem is to describe these. That is the topic of the lecture. The lecture is based on joint papers with Heinz Langer (University of Technology, Vienna) and Yuri Shondin (Pedagogical Institute, Nizhny Novgorod).

17:00-17:30 **Applications of Spaces with Indefinite Metrics**,
Babak Hassibi (California Institute of Technology)
No Abstract

17:30-18:00 **Sturm-Liouville Inverse Spectral Problems with Boundary Conditions Depending on the Spectral Parameter**,
Cornelis van der Mee, Vjacheslav Pivovarchik
(University of Cagliari, Italy)
The potential in a Schro"dinger equation on a finite interval with energy dependent boundary conditions is derived from its eigenvalues using the theory of Hermite-Biehler class entire functions.

18:00-18:30 **Variational Principles for Block Operator Matrices**,
Christiane Tretter (Universitaet Bremen),
Heinz Langer, Matthias Langer
(University of Technology, Vienna)
In this talk variational principles for block operator matrices are presented which are based on functionals associated with the quadratic numerical range and which allow to characterize, e.g., eigenvalues in gaps of the essential spectrum.

Room: 209, Session: MP5

Chair: Paul Fuhrmann
Title: **Algebraic Systems Theory**

16:30-16:50 **Further Results on Interconnection and Elimination for Delay-Differential Systems**,
Heide Gluesing-Luerssen
(University of Oldenburg, Germany)
We will consider a problem concerning the interconnection of systems from the behavioral point of view. The systems under consideration are linear, smooth, time-invariant, and have commensurate delays. We will give a characterization for the achievability of a given subsystem via regular interconnection from the overall system. This also leads to a criterion for achievability via regular interconnection followed by an elimination of the (then) latent variables.

16:50-17:10 **Reduction of Affine Systems on Polytopes**,
Jan H. van Schuppen, Luc C.G.J.M. Habets (Eindhoven University of Technology)
In an affine system on a polytope, state trajectories are terminated when they reach a facet of the polytope and attempt to exit. The realization problem for these systems is based on their behaviors, i.e. the set of input-output trajectories on time-intervals of either finite or infinite length. The state set can be reduced if and only if a subspace of the classical unobservable subspace, characterized by the normal vectors of the exit facets, is nontrivial.

17:10-17:30 **State Feedback Stabilization with Guaranteed Transient Bounds**,
Fabian Wirth, Diederich Hinrichsen, Elmar Plischke (Universitaet Bremen)
We analyze under which conditions linear time-invariant state space systems can be stabilized by static linear state feedback such that prescribed transient bounds hold pointwise in time. Necessary and sufficient conditions for stabilizability in this sense are derived for the quadratic stability definitions. While the general case is open, we obtain necessary and sufficient criteria for generating a strict contraction semigroup w.r.t. the spectral norm.

17:30-17:50 **Reduction of the Number of Parameters for all Stabilizing Controllers**,
Kazuyoshi Mori (The University of Aizu)
This paper presents a parameterization method of stabilizing controllers that needs smaller number of parameters than previous. The result in this paper will not assume the existence of the coprime factorizability and not employ the Youla parameterization.

17:50-18:10 **Structural Properties of LTI Singular Systems by Output Feedback**,
Runyi Yu (Eastern Mediterranean University), Dianhui Wang (La Trobe University, Australia)
Generic results regarding the structural properties of LTI singular system are presented in this paper. These include the structure of the system poles (both finite and infinite), assignment of the finite poles, elimination of the impulse mode, and controllability and observability of the closed-loop system. These properties are characterized by some new concepts defined in this paper.

18:10-18:30 **On Fliess Models over a Commutative Ring**,
Vakhtang Lomadze (University of Southampton)
Fliess models come as natural generalizations of classical polynomial models. As known, they are defined in terms of finitely generated modules and provide an adequate description of arbitrary linear systems (not necessarily observable or controllable). In this note we extend Fliess' approach to linear systems defined over an arbitrary commutative ring. We believe that the exposition will be of interest even for the field case.

Room: 210, Session: MP6
Chair: Daniel Liberzon
Title: **Hybrid Systems and Control**

16:30-17:00 **Nonlinear and Hybrid Control via RRTs**,
Michael Branicky, Michael M. Curtiss (Case Western Reserve University)
In this paper, we review rapidly-exploring random trees (RRTs) for motion planning, experiment with them on standard control problems, and extend them to the case of hybrid systems.

17:00-17:30 **Reachability Analysis of Hybrid Systems with Linear Dynamics**,
Mireille Broucke (University of Toronto)
We present results on the symbolic reachability analysis for hybrid systems with linear autonomous dynamics in each location.

17:30-18:00 **Towards the Control of Linear Systems with Minimum Bit-Rate**,
Joao Hespanha, Antonio Ortega, Lavanya Vasudevan (UC Santa Barbara)
We address the problem of determining the minimum bit-rate needed to stabilize a linear time-invariant process. For the noise free case, we determine a bit-rate below which stabilization is not possible and above which asymptotic stabilization can be achieved. Inspired by differential pulse code modulation techniques, we propose practical encoding/decoding schemes that guarantee boundedness of the state for the case of a noisy linear time-invariant process.

18:00-18:30 **Control of Hybrid Systems along Limit Cycles**,
Milos Zefran, Guobiao Song, Francesco Bullo (University of Illinois)
In this work we use semidefinite programming and the framework of piecewise linear systems to design controllers that stabilize a hybrid system to a limit cycle. Dynamics of a hybrid system along a periodic orbit is not continuous so the usual arguments that rely

on the smoothness of the system do not hold. This problem is motivated primarily by robotic walking devices, but it is relevant also for flight control systems and electrical power networks.

Tuesday August 13, 2002

8:00-9:00 *Room*: 101 Plenary Talk

Gilbert Strang (MIT),
Filtering and Signal Processing
We discuss two filters that are frequently used to smooth data. One is the (nonlinear) median filter, that chooses the median of the sample values in the sliding window. This deals effectively with "outliers" that are beyond the correct sample range, and will never be chosen as the median. A straightforward implementation of the filter is expensive, particularly in two dimensions (for images). The second filter is linear, and known as "Savitzky-Golay". It is frequently used in spectroscopy, to locate positions and peaks and widths of spectral lines. This filter is based on a least-squares fit of the samples in the sliding window to a polynomial of relatively low degree. The filter coefficients are unlike the equiripple filter that is optimal in the maximum norm, and the "maxflat" filters that are central in wavelet constructions. We will discuss the analysis and the implementation of both filters.

9:00-10:00 *Room*: 101 Invited Talk

Arjan van der Schaft (University of Twente),
Mathematical Theory of Network Models of Physical Systems
Prevailing trend in the modeling and simulation of complex (lumped-parameter) physical systems is modular modeling, where the complex physical system is represented as the network interconnection of ideal elements. This has many advantages in terms of flexibility, re-usability of model parts, and support for automated modeling. The viewpoint of network modeling necessarily leads to the consideration of open dynamical systems, that is, dynamical systems with external variables, which can be interconnected to other open systems. This viewpoint is fundamental to systems and control theory, where the analysis of complex systems is based on the properties of the sub-systems and the way they are interconnected to each other, and the behavior of the complex system is sought to be influenced and regulated by the addition of additional feedback loops and control components. On the other hand, the equations of motion obtained from direct network modeling are often complicated and without apparent structure, and easily contain algebraic constraints arising from the interconnection of the sub-systems. As such, they may not be well-suited for analysis,simulation and control. The aim of this presentation is to show how a particular type of network modeling, namely port-based modeling, where the sub-systems are interacting with each other through power exchange represented by pairs of conjugated variables, immediately leads to generalized Hamiltonian equations of motion. In fact, the interconnection structure of the complex system, together with power-preserving elements like transformers and workless constraints, defines a geometric object; called a Dirac structure. The equations of motion are Hamiltonian with respect to this Dirac structure and the Hamiltonian defined by the total energy of the system, together with the energy-dissipation structure. The resulting class of geometrically defined systems are called port-Hamiltonian systems. This framework offers many possibilities for analysis, simulation and control, which we will briefly address. In particular, we will indicate how a given port-Hamiltonian plant system can be controlled by interconnecting it with a controller port-Hamiltonian system, and how this extends classical passivity theory. Finally, we show how the framework can be extended to boundary controlled distributed-parameter systems, by considering infinite-dimensional Dirac structures based on Stokes' theorem.

9:00-10:00 *Room*: 102 Invited Talk

Robert J. McEliece (Cal Tech),
Belief Propagation on Partially Ordered Sets
The field of error-correcting codes has been revolutionized by the advent of suboptimal iterative decoding methods, for example turbo-decoding and iterative decoding of low-density parity-check (LDPC) codes. Several years ago it was recognized that all scuh decoding algorithms are special cases of Pearl's "belief propagation" algorithm applied to graphs with cycles, although BP isn't supposed to work when cycles are present! In this talk I will review the state of our understanding of loopy BP, and will, motivated by the recent work of Yedidia, Freeman, and Weiss, introduce a promising generalization of BP in which the messages are passed not along the edges of a graph, but rather along the edges of the Hasse diagram of a finite partially ordered set.

9:00-10:00 *Room*: 129 Invited Talk

Jeff Wood (University of Southampton),
Modules and Behaviors: Re-examining Oberst's Duality
The module associated to a system, and the duality between system modules and system behaviors, will be introduced from a natural point of view. We will examine how injectivity of the signal space is related to the elimination problem, and the cogenerator property to identifiability. We will also introduce 'abstract behaviours', which are independent of any embedding in a trajectory space. However, most of the talk will be of a tutorial nature and will be illustrated by the case of systems defined by linear ordinary/ partial constant coefficient differential equations.

Morning:

Room: 102, Session: TUA1

Chair: Heide Gluesing-Luerssen
Title: **Design and Analysis of Block Codes, Part I**

10:30-11:30 **Iterative Decoding and Design of Codes on Graphs**,
Pascal O. Vontobel (ETH)
The concept of factor graphs and the sum-product algorithm is one possible way to understand the difference between codes suitable for iterative decoding and "traditionally good" codes. After stating some desirable properties of factor graphs, we will review different approaches given in the literature leading to random and algebraic constructions of turbo, low-density parity-check, and other codes.

11:30-12:00 **Codes for Networks**,
Ralf Koetter (University of Illinois)
We investigate connections between coding for networks s suggested by Ahlswede et al. and linear system theory. In particular we focus on structure theorems for linear systems on arbitrary graphs. Such a linear system may be described by a trellis on the underlying graph. Employing various duality results from the theory of trellises and generalized state realizations, we give an algorithm that for a given networking problem achieves a locally optimal solution.

12:00-12:30 **Unitary Constellation Design with Application to Space-time Coding**,
Guangyue Han, Joachim Rosenthal
(University of Notre Dame)
Unitary modulation scheme in Rayleigh flat fading channel with multiple antennas requires us to design certain space-time codes to increase the channel capacity and lower the bit error probability at the same time. In this paper, we design some specific constellations according to two design criteria and their transformations. Some of our codes feature good performance and efficient decoding algorithms.

Room: 126, Session: TUA2

Chair: Wijesuriya P. Dayawansa
Title: **Patterns in Biology**

10:30-11:00 **Visual Systems**,
Bijoy Gosh, A. Polpitiya
(Washington University St.Louis)
No Abstract

11:00-11:30 **The Dynamics of Avian Kinesis**,
Lawrence Schovanec, Alan Barhorst, Sankar Chatterjee
(Texas Tech University)
Unlike most vertebrates, birds can raise the upper jaw with respect to the brain case, a feature known as cranial kinesis. This property makes it possible for birds to create a wide gape and fast movement of the bills. This paper provides a method for assessing how neural controls and physiological variations affect the gape, speed of movement, and the magnitude of forces generated by the jaw. This is achieved by incorporating joint torques derived from muscultendon dynamics into the equations of motion for the system modeled as a system of articulating segmental links, closed loops and distributed elastic components. The method accounts for both the rigid body motions and the elastic deformations of the articulating components. This is accomplished by using a nonholonomic hybrid parameter projection method in which the dynamics are projected onto the constraint-free manifold of the generalized speed space and thus require no algebraic constraint conditions. Numerical simulations and analysis of the system provide insight into how the biomechanical are related to functional issues of the avian skull as well as evolution of the system.

11:30-12:00 **Spiral Waves in the Heart**,
Clyde Martin, P. Marcus
(Texas Tech University)
A major problem that is being considered by several groups around the world is to model the electrical and muscular actions of the mammalian heart. These efforts vary greatly in complexity. At the most complicated level the model is developed at the cellular level and the detailed physiology is taken into account. These models are very difficult to simulate, often requiring hours or days of super computer time for a

few milliseconds to seconds of heart time. However the result is very accurate simulation. At the simplest level the heart is modeled as a single partial differential equation. These models are easy to simulate and several minutes of heart action can be realized in at most a few minutes of computer time. However, it is very difficult to relate the results to physiological assumptions. We have worked extensively with these models and are able to develop some understanding of the relation of the models to the cardiac fibrillation. We are now in the process of developing models that are intermediate to these two classes of models.

12:00-12:30 **Large Amplitude Travelling Waves in Coupled Oscillater Networks**,
Wijesura P. Dayawansa, Clyde Martin
(Texas Tech University)
Theory of small amplitude oscillations in coupled oscillator networks is well established. However, when the value of bifurcation parameters become large, the analysis of such networks become rather complex. A network consisting of cubic oscillatos is considered here, and it is shown that it is possible to increase bifurcation parameters so as to maintain the simplicity of resulting oscillation patterns, leading to a mechanism to generate complex spiking trains.

Room: 129, Session: TUA3

Chair: Victor Vinnikov, Joseph A. Ball
Title: **Minicourse A: Multidimensional Systems**

10:30-12:30 **Overdetermined Multidimensional Systems and Applications**,
Victor Vinnikov (Ben Gurion University of the Negev)
Joseph A. Ball
(Virginia Tech)
We consider 2D ISO linear systems where the evolution of the whole state is specified in two independent directions. The requirement that the value of the state at a given point be independent of the path from the origin chosen to arrive at the given point leads to nontrivial consistency conditons: the transienct evolutions should commute and the input (and output) signal should satisfy a nontrivial compatibility PDE/DE. Many of the standard structural properties and operations for traditional linear systems (controllbility, observability, minimality, pairing with the adjoint system, feedback coupling, equivalence between conservative systems and Lax-Phillips scattering theory) carry over for this setting. There is also a frequency-domain theory for this class of systems (the transfer function is a bundle map between flat vector bundles on a Riemann surface, or equivalnetly between kernel bundles for determinantal representations of an algebraic curve), and there is a Laplace transform (continuous time) or Z-transform (discrete time) along the discriminant curve which implements the transformation from time domian to frequency domain. In addition to analogues of the usual problems from system theory, we mention two applications beyond the usual scope of system theory: wave-particle duality in quantum mechanics, and a mathematical model for DNA chains.

Room: 136, Session: TUA4

Chair: Lars Gruene, Fabian Wirth
Title: **Input-to-State Stability, Part I**

10:30-11:00 **Attractors, Input-to-State-Stability, and Control Sets**,
Fritz Colonius (University of Augsburg),
W. Kliemann (Iowa State University)
The relations between attractors, ISS and controllability properties are discussed. In particular, it is shown, that loss of the attractor property under perturbations is connected with a qualitative change in the controllability properties due to a merger with a variant control set.

11:00-11:30 **Output-Input Stability of Nonlinear Systems and Input/Output Operators**,
Daniel Liberzon (University of Illinois)
The recently proposed definition of output-input stability requires the state and the input of the system to be bounded in terms of the output and derivatives of the output. The present work extends this concept to the setting of input/output operators. We show that output-input stability of a system implies output-input stability of the associated input/output operator, and that under suitable reachability and observability assumptions, a converse result holds.

11:30-12:00 **A Parameter-Robust Observer as an Application of ISS Techniques**,
Madalena Chaves (Rutgers University)
Systems that model chemical networks are often defined through a set of parameters (the reaction rate constants) whose values may be determined with a small margin of error. These parameters will typically also appear in the construction of observers. A definition of parameter-robustness is proposed and an explicit observer for zero-deficiency chemical networks is presented, which is robust in this sense.

12:00-12:30 **Quantitative Aspects of the Input-to-state Stability property**,
Lars Gruene (J.W. Goethe-Universitaet Frankfurt)
In this talk we consider quantitative aspects of the input-to-state stability (ISS) property. Our considerations lead to a new variant of ISS, called input-to-state dynamical stability (ISDS). The main feature of ISDS is that it admits a quantitative Lyapunov function characterization. We clarify the relation to the original ISS formulation and present several applications.

Room: 208, Session: TUA5

Chair: Anders Rantzer
Title: **Linear Systems**

10:30-10:50 **A New Property of Laguerre Functions**,
Luigi Fortuna, Riccardo Caponetto, Mattia Frasca (University of Catania, Italy)
Laguerre filters constitute an orthonormal basis for the Hilbert space, for this they are used in system identification and reduced-order modelling. In this paper a new property of Laguerre filters is introduced: it is shown that the system having as transfer function the sum of the first n+1 functions has all the singular values equals each other. On the basis of this property a generalization of Laguerre filters is proposed.

10:50-11:10 **Communication-Limited Stabilisability of Jump Markov Linear Systems**,
Girish Nair, Subhrakanti Dey, Robin Evans (University of Melbourne)
This paper investigates the control of fully observed, scalar jump Markov linear systems in which feedback is transmitted at finite data rates over noiseless digital channels. In particular, the objective is to find the infimum data rate, over all causal coding and control laws, at which asymptotic closed-loop stability in m-th absolute output moment is achievable.

11:10-11:30 **Equivalence of Finite Pole Assignability of LTI Singular Systems by Output Feedback**,
Runyi Yu (Eastern Mediterranean University), Dianhui Wang (La Trobe University, Australia)
This paper shows that the assignability of finite poles of a strongly controllable and observable singular system (E, A, B, C) is equivalent to the pole assignability of a non-singular system (As, Bs, Cs) of order rank(E). Consequently, all the existing results on pole assignment of non-singular systems can be extended to singular systems as far as the finite poles are concerned.

11:30-11:50 **On Kalman Models over a Commutative Ring**,
Vakhtang Lomadze (University of Southampton)
There is a good notion of rational functions with coefficients in a commutative ring. Using this notion, we easily obtain a neat generalization of Chapter 10 of the classical book by Kalman et al. to linear systems over an arbitrary commutative ring. The generalizations certainly exist already. However, we believe that the approach we present is more natural and straightforward.

11:50-12:10 **On Rosenbrock Models over a Commutative Ring**,
Vakhtang Lomadze (University of Southampton)
Rosenbrock's notion of system equivalence is general in nature; it is a kind of equivalence which in algebra is often termed as stable. We have shown recently that Fuhrmann's notion of system equivalence can be viewed as a homotopy equivalence, and as such is also general in nature. This note deals with a generalization of the theory of system equivalences from the field case to the commutative ring case.

12:10-12:30 **Inclusion of Frequency Domain Behaviors**,
Stephen Prajna (Cal Tech), Pablo A. Parrilo (ETH)
This paper addresses inclusion of behaviors and its verification. It is shown that verifying inclusion of frequency domain behaviors defined by polynomial frequency domain equalities and inequalities amounts to proving emptiness of some basic semialgebraic sets. A semidefinite programming relaxation method for solving this problem is outlined. Some applications are given to illustrate the use of the concepts.

Room: 209, Session: TUA6

Chair: Viswanath Ramakrishna
Title: **Quantum Engineering I**

10:30-11:10 **A Numerical Approach to the Design of Strongly Modulating Pulses to Implement Precise Effective Hamiltonians for Quantum Information Processing**,
Timothy Havel, Nicolas Boulant, David G. Cory, Evan M. Fortunato, Marco A. Pravia, Grum Teklemariam (MIT)
Unitary "logic gates" to are used to process quantum information: the state of a 2-D quantum system, or "qubit". In many approaches to QIP, the gates are

implemented by modulating the system's internal dynamics with piecewise constant external control fields, or "pulses". This talk describes a numerical approach to designing pulse sequences which yield unitary gates with high precision. The results of NMR experiments demonstrating these pulses will also be presented.

11:10-11:50 **System Theoretic Aspects of NMR Spectroscopy**,
Raimund J. Ober (University of Texas at Dallas)
No Abstract

11:50-12:10 **Local and Global Control of Population Transfer in Quantum Systems**,
Vladimir S. Malinovsky (University of Michigan),
Stimulated Raman Adiabatic Passage (STIRAP) has proven to be an efficient and robust technique of population transfer in three-level and multilevel systems. On the other hand, the studies of optimal pulse shaping to control atomic or molecular dynamics have reached a high degree of sophistication, specially since the advent of the use of Optimal Control Theory (OCT). In this contribution we show the connection between the counterintuitive pulse sequence in STIRAP and the population locking condition of intermediate levels. The relationship between several versions of OCT called local optimization methods and STIRAP is also discussed.

12:10-12:30 **Hartree-Fock Models in Electronic Structure Computations,**
Gabriel Turinici
(INRIA Rocquencourt/ CERMICS-ENPC, France)
This talk will present, in a pedagogical manner, an algorithmic overview of the resolution of the Hartree-Fock problem. Although initially set as a minimisation problem, most traditional implementation use the Euler-Lagrange critical point equations that give rise to a nonlinear eigenvalue problem. It will be seen next that the modern approaches try to come back to the minimisation framework in a search for efficiency.

Room: 210, Session: TUA7

Chair: Stephen Campbell, Ramine Nikoukhah
Title: **Robust Estimation, Identification, and Detection**

10:30-11:00 **A Survey of Input-Output Methods in Robust Estimation**,
Babak Hassibi (Cal Tech)
No Abstract

11:00-11:30 **Robust Least-Squares Filtering with a Relative Entropy Constraint**,
Bernard Levy (University of California at Davis),
Ramine Nikoukhah (INRIA)
We consider a robust Wiener filtering problem for wide-sense stationary processes in the presence of modelling errors. It requires solving a minimax problem consisting of finding the best filter for the least-favorable statistical model within a neighborhood of the nominal model, which is specified by the relative entropy with respect to the nominal model. The standard noncausal Wiener filter is optimal, and in the causal case a characterization is provided for the best filter and corresponding least-favorable model.

11:30-12:00 **Bounding the Solution Set of Uncertain Linear Equations: a Convex Relaxation Approach**,
Giuseppe Calafiore (Politecnico di Torino),
Laurent El Ghaoui (UC Berkely)
In this paper, we discuss semidefinite relaxation techniques for computing minimal size ellipsoids that bound the solution set of a system of uncertain linear equations (ULE). The proposed technique is based on the combination of a quadratic embedding of the uncertainty, and the S-procedure. The resulting bounding condition is expressed as a Linear Matrix Inequality (LMI) constraint on the ellipsoid parameters and the additional scaling variables. This formulation leads to a convex optimization problem that can be efficiently solved by means of interior point barrier methods.

12:00-12:30 **The Design of Auxiliary Signals for Robust Active Failure Detection in Uncertain Systems**,
Stephen Campbell (North Carolina State University),
Ramine Nikoukhah (INRIA)
By modeling the normal and the failed behaviors of a process by two or more linear uncertain systems, failure detectability in linear systems can be seen as a linear multi-model identification problem. This paper describes an active approach for multi-model identification using minimal auxiliary signals. Both additive and model uncertainty are included in this approach.

Middle:

Room: 102, Session: TUM1

Chair: Daniel Costello
Title: **Design and Analysis of Block Codes, Part II**

14:00-14:30 **On a Few Classes of Optimal and Near-optimal Polynomial Codes**,
Nuh Aydin (Ohio State University)
We generalize a recent idea of constructing codes over a finite field $\mathbb{F}_q$ by evaluating certain collection of polynomials over $\mathbb{F}_q$ at elements of an extension field. We show that many codes with the best-known parameters can be obtained with this construction. In particular, a new linear code, a $[40, 23, 10]$-code, over $\mathbb{F}_5$ is discovered. Moreover, several families of optimal and near-optimal codes are obtained by this method. We call a code near-optimal if its minimum distance is within 1 unit of the known upper bound.

14:30-15:00 **Building Low-Density Parity-Check Codes with Affine Permutation Matrices**,
Michael O'Sullivan, Marcus Greferath, Roxana Smarandache
(San Diego State University)
We will expand on a technique due to Hui et al for constructing low density parity check codes using blocks of matrices, each constructed as a sum of permutation matrices. The permutation matrices that we use are defined by an affine congruence equation.

15:00-15:30 **On Plotkin and Elias Bounds for Codes over Frobenius Rings under the Homogeneous Weight**,
Marcus Greferath (San Diego State Univ.)
Homogeneous weights were introduced by W. Heise and I. Constantinescu in 1995. They appear as a natural generalization of the Hamming weight on finite fields and the Lee weight on $\mathbb{Z}_4$ and have proven to be important in further significant papers. This article developes a Plotkin and an Elias bound for codes on finite Frobenius rings that are equipped with this weight. Surprisingly these bounds have the same form as in the case of the Hamming weight on a finite field. Their proof however requires different techniques than the classical proof: we make use of their representation by generating characters on the finite Frobenius ring in question.

15:30-16:00 **Four and Six-Dimensional Signal Constellations from Algebraic Lattices**,
Carmelo Interlando (University of Notre Dame),
Michele Elia (Politecnico di Torino)
We describe a procedure to construct signal constellations from lattices associated to rings of algebraic integers. The procedure provides a natural way to label the constellation points by elements of GF(q). The labeling is proven to be linear which allows, at the receiver, a fast way to map constellation points into field elements. The constellations performance is determined by their minimum Euclidean distance and average energy, for rates from 1 up to 3.

Room: 126, Session: TUM2

Chair: Raimund Ober
Title: **Immunology 1: Introduction and Microscopy**

14:00-14:40 **Introduction to Workshop and Overview**,
Raimund Ober (University of Texas at Dallas)
A short introduction to minisymposium will be presented by presented an overview of the topics that will be considered in the mini-symposium.

14:40-15:20 **T Cell Receptor MHC Interactions: An Overview**,
E. Sally Ward (University of Texas at Dallas)
A tutorial exposition is given of the biology and in particular immunology that is central for the understanding of the topics that will be presented in the mini-symposium by other speakers. This presentation should be of particular interest to attendees of the conference who are not familiar with these topics.

15:20-16:00 **Image Formation and Deconvolution for 3 Dimensional Microscopy of Cell Samples**,
Jose Angel Conchello (Washington University St.Louis)
No Abstract

Room: 129, Session: TUM3

Chair: Krzystof Galkowski, Eric Rogers, Victor Vinnikov
Title: **Multidimensional Systems 1**

14:00-15:00 **2D Linear Control Systems - From Theory to Experiment to Theory**,
Eric Rogers, Tarek Al-Towlem,
James Radcliffe, Paul Lewin
(University of Southampton),
Krzysztof Galkowski (University of Zielona Gora),
David Owens (University of Southampton)
The subject area of this paper is the application of systems theory developed for linear repetitive processes, a distinct class of 2D linear systems, to linear itera-

tive learning control schemes. A unique feature is the inclusion of experimental results obtained from the application of control laws designed using this theory to an experimental rig in the form of a chain conveyor system.

15:00-15:30 **Stability Analysis of 2D Dynamics in Roessers Model**,
Tatsushi Ooba, Yasuyuki Funahashi
(Nagoya Institute of Technology)
State-space stability of linear shift-invariant discrete two-dimensional (2-D) dynamics is considered. An approach to the making of Lyapunov functions for 2-D dynamics is presented. It produces a quadratic form involving finite cross-terms among local states. The use of the quadratic form expands the scope of the stability analysis based upon the notion of parallel stability expands.

15:30-16:00 **Algebraic Algorithm for 2D Stability Test Based on a Lyapunov Equation**,
Minoru Yamada
(Gifu National College of Technology),
Li Xu (Akita Prefectural University),
Osami Saito (Chiba University)
Agathoklis proposed the 2D stability conditions based on the Lyapunov approach. In this paper, some improvements have been proposed for the algorithm of Agathoklis so that 2D stability test can be realized by totally algebraic operations.

Room: 208, Session: TUM4
Chair: Joseph A. Ball, Hugo Woerdeman
Title: **Recent Developments on Interpolation and Completion Problems**

14:00-14:20 **Feedback Control for Multidimensional Systems and Interpolation Problems for Multivariable Functions**,
Joseph A. Ball, Tanit Malakorn
(Virginia Tech)
We examine the connections between and the state of art on feedback stabilization and H-infinity control, model matching problems, and multivariable Nevanlinna-Pick interpolation problems for the case of multidimensional or nD linear systems.

14:20-14:40 **On the Caratheodory-Fejer Interpolation Problem for Generalized Schur Functions**,
Vladimir Bolotnikov
(The College of William and Mary)
The solutions of the Carathéodory–Fejér interpolation problem for generalized Schur functions can be parametrized via a linear fractional transformation

$$S(z) = \frac{A(z)E(z) + B(z)}{C(z)E(z) + B(z)},$$

where A, B, C and D are polynomials depending explicitly on the data of the problem and E is the parameter varying over the class of classical Schur functions (i.e., analytic and contractive on the unit disk) such that $CE + D$ does not vanish at interpolating points. All other parameters E are called excluded and the corresponding functions S may have a pole (simple or multiple) in one or more of the interpolation points or not satisfy one or more interpolation conditions. We present a classification of excluded parameters E and related functions S in terms of the Pick matrix of the interpolation problem.

14:40-15:00 **Abstract Interpolation in Scattering Setting**,
Alexander Kheifets
(The College of William and Mary)
Abstract Interpolation scheme is adapted to the case of nonanalytic (harmonic) interpolation. Unitary colligation yields a scattering system, orthogonality assumptions are given up (i.e. analyticity is not necessarily holds). Wandering subspaces are replaced by an arbitrary scale (i.e. incoming and outgoing subspaces are not distinguished). The modified version covers, in particular, Nehari and Commutant Lifting problems directly.

15:00-15:20 **A Convex Optimization Approach to Generalized Moment Problems**,
Anders Lindquist (KTH),
C. I. Byrnes (Washington University, St. Louis)
We present a universal solution to the generalized moment problem, with a nonclassical complexity constraint, obtained by minimizing a strictly convex nonlinear functional.This optimization problem is derived in two different ways, first geometrically by path integration of a one-form, and second via duality theory of mathematical programming. The solution is then applied to interpolation problems and to estimation of probability distributions.““

15:20-15:40 **Extremal Properties of Outer Factors**,
Scott McCullough (University of Florida)
Each of the coefficients of the outer and $*$-outer factor of a polynomial $p(t)$ which is non-negative on for real t are larger, in absolute value, of the corresponding coefficient of any other factor even for matrix-valued factors.

15:40-16:00 **On the Realization of Inverse Stieltjes Functions**,
E. R. Tsekanovskii (Niagara University),
Sergey Belyi (Troy State University),
Seppo Hassi (University of Vaasa, Finland),
Henk de Snoo (University of Groningen)
A survey of recent results in realization theory of Herglotz-Nevanlinna matrix-valued functions, interpolation problems and explicit system solutions obtained by the author and D.Alpay, S.Belyi, S.Hassi, H.de Snoo is presented.We consider a new type of solutions of Nevanlinna-Pick interpolation problems, so called, explicit system solutions and find conditions on interpolation data of their existence, uniqueness and restoration.

Room: 209, Session: TUM5

Chair: Damir Arov
Title: **Control of Distributed Parameter Systems**

14:00-14:30 **Optimal Control and Riccati Equations for a Degenerate Parabolic System**,
Jean-Marie Buchot (Onera-Toulouse),
Jean-Pierre Raymond (Université Paul Sabatier)
In this paper, we consider a stabilization problem for a fluid flow. For a perturbation of the velocity of an incoming flow on a flat plate, the laminar-to-turbulent transition location varies. We want to stabilize it by a suction velocity trough the plate. We look for a suction velocity in a feedback form, determined by solving a LQR problem with an infinite time horizon.

14:30-15:00 **Nonlinear Predictive Control of Flexible Manipulator Systems**,
Alaa Mohamedy, Andrzej Ordys, Michael Grimble (University of Strathclyde)
The paper discusses predictive control algorithms in the context of applications to robotics and manufacturing systems. Lagrangian mechanics and the assumed mode methods have been used to drive a proposed dynamic model of a single-link flexible manipulator having a revolute joint. The model may be used in general to investigate the motion of the manipulator in the horizontal plane rest-to-rest rotational maneuver. Then, a nonlinear predictive controller is designed on the basis of a Nonlinear Quadratic Gaussian Predictive Optimal Control (NLQGPC) using the receding-horizon control approach. Based on the (NLQGPC), the control law is derived by minimizing a quadratic cost function that penalizes future tracking errors and control torques. Simulation results are presented for a single-link flexible manipulator to achieve a desired angular rotation of the link while simultaneously suppressing structural vibrations. The results are illustrated by a numerical example.

15:00-15:30 **Furtivity and Masking Problems in Acoustics**,
Francesco Zirilli (University " La Sapienza" - Rome)
We consider the time dependent acoustic scattering phenomena associated to an incoming acoustic field that hits a bounded simply connected obstacle with Lipschitz boundary and known acoustic boundary impedance. In this context we study furtivity and masking problems. These problems are formulated as optimal control problems for the wave equation and solved using the Pontryagin maximum principle via an appropriate numerical method.

15:30-16:00 **Approximation of Optimal Controls for Semi-Linear Parabolic PDE by Solving Hamilton-Jacobi-Bellman Equations**,
Sophie Gombao (University Paul Sabatier)
This paper presents a numerical approximation of optimal controls by discretization of a Hamilton-Jacobi-Bellman (HJB) equation, coming from a family of optimal control problems of parabolic PDE. The method is based on model reduction, using POD (Proper Orthogonal Decomposition), and on the approximation of the HJB equation of the reduced problem by finite difference scheme.

Room: 210, Session: TUM6

Chair: Anders Lindquist
Title: **Filtering and Identification**

14:00-14:20 **System Identification of Nonlinear Dynamic Systems with Multiple Inputs and Single Output Using Discrete-Time Volterra Type Equations**,
Thomas Treichl, Stefan Hofmann, Dierk Schröder (TU München)
A theoretical framework about the identification of nonlinear dynamic systems with multiple inputs and single output is presented. Basic considerations about discrete-time Volterra type equations are performed. It is shown how measuring equations can be obtained from nonlinear and arbitrary coupled linear time-invariant transfer functions and nonlinear static functions. With a simulation example the presented identification method is evaluated.

14:25-14:45 **Data Driven Local Coordinates**,
Thomas Ribarits, Manfred Deistler, Bernard Hanzon (University of Technology Vienna)

In this paper we study a rather novel parametrization for state-space systems: data driven local coordinates (DDLC) as introduced in (McKelvey and Helmersson, 1999). We provide some insights into the geometry and topology of the DDLC construction and show a number of results for this parametrization which are also important for actual computations using DDLC.

14:50-15:10 **Using Rank Order Filters to Decompose the Electromyogram**,
Dawnlee Roberson, Cheryl Schrader
(University of Texas at San Antonio)
This research applies nonlinear filters to model generated muscle and nerve signals and compares the results to determine correlation. The authors generate three data test sets that range from simple (no noise) to fairly complex (noisy, varied amplitude) and apply a Rank Order filter family to the rectified generated electromyographic signals in an attempt to recover the original (nerve) signal. Promising results occur even in the most challenging case.

15:15-15:35 **Conditioning Analysis of a Continuous Time Subspace-Based Model Identification Algorithm**,
Juan Carlos Martinez-Garcia
(Instituto Mexicano del Petroleo), G.H. Salàzar-Silva, R. Garrido
(CINVESTAV-IPN)
We present in this paper a study concerning the conditioning analysis of a continuous-time deterministic subspace-based model identification algorithm. We show that the conditioning number of the associated extended observability matrices depends on an exponential way from both: the estimated order of the system and the dimension of the system output vector.

15:40-16:00 **On Model and State Estimation under Mixed Uncertainty**,
Irina Digailova, Alexander B.Kurzhanski
(Moscow State (Lomonosov) University)
The paper deals with joint estimation of the state space variables and the transition function of a system with original linear structure through available measurements corrupted by uncertain disturbances. These are of the "mixed' type, combining unknown but bounded, stochastic Gaussian and H-infinity type disturbances. The results are given in either recurrent pointwise form or through "infomation sets" or "confidence domains".

Afternoon:

Room: 102, Session: TUP1

Chair: Heide Gluesing-Luerssen
Title: **Convolutional Codes**

16:30-17:00 **Construction and Decoding of Strongly MDS Convolutional Codes**,
Roxana Smarandache (San Diego State University), Heide Gluesing-Luerssen (University of Oldenburg), Joachim Rosenthal (University of Notre Dame)
A new class of of rate 1/2 convolutional codes called strongly MDS convolutional codes are introduced and studied. These are codes having optimal column distances. Properties of these codes are given and a concrete construction is provided. This construction has the ability to correct δ errors in any sliding window of length $4\delta + 2$ whereas the best known MDS block code with parameters $[n, n/2], n = 4\delta + 2$, can correct δ errors in any slotted window of length $4\delta + 2$. A decoding algorithm for these codes is given in the end of the paper.

17:00-17:30 **On Observers and Behaviors**,
Paul A. Fuhrmann (Ben-Gurion University)
In this talk, we explore the connection between the classic, input output based theory of observers for linear functions of the state and the theory of behavior based observers as developed in the paper Valcher and Willems [1999].

17:30-18:00 **On the Convergence of Nonsystematic Turbo Codes**,
Daniel Costello Jr., Adrish Banerjee
(University of Notre Dame),
Francesca Vatta (Università di Trieste),
Bartolo Scanavino (Politecnico di Torino)
In this paper, we study the convergence behavior of nonsystematic feedback convolutional encoders used as constituent encoders in a parallel concatenated (turbo) coding scheme. We use mutual information based EXIT charts to visualize the decoding trajectory of different nonsystematic encoders employing an iterative MAP decoding algorithm. It is observed that encoders with low weight feedforward inverses perform better under low signal-to-noise ratio conditions. Catastrophic encoders, which have an infinite weight feedforward inverse, can also be made to converge by doping the code with some systematic bits. We also present some BER performance curves for nonsystematic turbo codes and compare them to systematic turbo codes.

18:00-18:30 **Some Small Cyclic Convolutional Codes**,
Heide Gluesing-Luerssen, Wiland Schmale, Melissa Striha
(University of Oldenburg)
In this note we will construct and investigate some small cyclic convolutional codes. Among other things we will present an infinite series of one-dimensional CCCs over the field with 4 elements having length 3 and increasing constraint length (complexity). Our computations show that the first codes in this series have very good free distances.

Room: 126, Session: TUP2

Chair: Raimund Ober
Title: **Immunology 2: Microscopy and Biophysics**

16:30-17:10 **Microscopic Investigation of Synapse Formation**,
Michael Dustin (NYU School of Medicine)
No Abstract

17:10-17:50 **Studying Protein-Protein Interactions: Biosensor Technology**,
Peter Schuck (National Institutes of Health)
No Abstract

17:50-18:30 **Protein Dynamics near Membrane Surfaces: New Aspects of Local Coupled Reaction and Transport**,
Nancy L. Thompson (University of North Carolina at Chapel Hill)
No Abstract

Room: 129, Session: TUP3

Chair: Krzystof Galkowski, Eric Rogers, Victor Vinnikov
Title: **Multidimensional Systems 2**

16:30-17:00 **State Representation of nD Behaviors**,
Isabel Bràs, Paula Rocha
(University of Aveiro, Portugal)
In this paper we study the existence of state/driving-variable (SDV) representations for discrete nD kernel behaviors. It turns out that, as in the 2D case, an nD kernel behavior is SDV-representable if and only if it has an SDV-representable autonomous part. Additionally, we give a necessary condition for the state representability of nD autonomous behaviors.

17:00-17:30 **The Bang-Bang Principle for the Goursat-Darboux Problem**,
Dariusz Idczak (University of Lodz)
In the paper, the bang-bang principle for a control system connected with a system of linear nonautonomous partial differential equations of hyperbolic type (the so-called Goursat-Darboux problem or continuous Fornasini-Marchesini problem) is proved. Some density result for piecewise constant controls is also obtained.

17:30-18:00 **Elimination of Anticipation of Singular 2D Roesser Model**,
Tadeusz Kaczorek (Technical University Warsaw)
Necessary and sufficient conditions for the anticipation of singular 2D Roesser model are established. Three methods of elimination of the anticipation of the model are proposed. In the first method the elimination of the anticipation is achieved by connection in series with the anticipatory model of a suitable number of delay elements. In the next two methods the elimination of anticipation is achieved by suitable choice of feedback gain matrices. The methods are illustrated by numerical examples.

18:00-18:30 **Difference Equations and n-D Discrete Systems**,
Jiri Gregor (Czech Technical University)
Discrete systems are often described by difference equations. With some attributes of initial state type, a difference equation defines a system, i.e. a set of (input,output) pairs. For systems defined by linear difference equations (with constant or variable coefficients) on arbitrary subsets of the n-dimensional grid sufficient conditions of their stability are formulated. These conditions also enable to obtain growth estimates for outputs of such systems. Examples illustrate the results.

Room: 136, Session: TUP4

Chair: Matthias Kawski
Title: **Nonlinear Systems and Control 3**

16:30-16:50 **Disturbance Attenuation for a Class of Nonlinear Systems by Output Feedback**,
Wei Lin, Xianqing Huang
(Case Western Reserve University),
Chunjiang Qian (University of Texas at San Antonio)
This paper studies the problem of disturbance attenuation with internal stability via output feedback for a family of nonlinear systems. Using a feedback domination design which substantially differs from the separation principle, we explicitly construct a dynamic

output compensator attenuating the disturbance's effect on the output to an arbitrary degree of accuracy in the L2 gain sense and achieving GAS in the absence of disturbance.

16:50-17:10 **A Linear Controller for a Multifrequency Model of a Pulse-Width-Modulated Cuk Converter**,
Yusuf Fuad, J.W. van der Woude, W.L. de Koning
(Delft University of Technology)
This paper presents a linear controller for a multifrequency model of a pulse-width-modulated Cuk converter. The controller is based on an equivalent discrete-time version of the linearized multifrequency model and uses the continuous-time output over one switching period. Using this combination we determine the duty ratio at the beginning of every switching period. We discuss how this controller, designed for an arbitrary number of harmonics, can be applied in a realistic situation. Simulations are given to demonstrate the influence of the controller on the response of the system.

17:10-17:30 **Synergetic Synthesis of Nonlinear Kinematics Regulators for Mobile Robots**,
Boris Topchiev
(Taganrog State University, Russia)
We suggest new control strategy for mobile robots. This strategy based on forming some desired behavior structure. Desired structure is introducing to control laws by using methods of synergetic theory of control.

17:30-17:50 **On the Convergence of a Feedback Control Strategy for Multilevel Quantum Systems**,
Paolo Vettori (University di Padova)
We present in this paper a class of feedback strategies that solve the steering problem for finite dimensional quantum systems. The control is designed to let a suitable distance between the state and the target decrease. Sufficient conditions are given to ensure convergence of this process.

18:10-18:30 **Global Output Feedback Control with Disturbance Attenuation for a Class of Nonlinear Systems**,
Xianqing Huang, Wei Lin
(Case Western Reserve University)
No Abstract

Room: 209, Session: TUP5

Chair: Ruth Curtain
Title: **Infinite Dimensional Systems**

16:30-17:00 **Observability Analysis of a Nonlinear Tubular Reactor**,
Cedric Delattre, Denis Dochain (CESAME UCL),
Joseph Winkin (University of Namur (FUNDP))
An observability analysis is performed on a linear PDE with a spatial-dependent coefficient, that is the linearized model of a nonlinear tubular bioreactor. It is shown that the associated linear infinite-dimensional operator is a Riesz-spectral operator and that a finite number of dominant modes of the system are observable when the substrate concentration is measured at the reactor output. This result is confirmed by a numerical simulation.

17:00-17:30 **A Hilbert Space Approach to Self-Similar Systems**,
Mamadou Mboup
(Université René Descartes - Paris V)
This paper investigates the structural properties of linear self-similar systems, using an invariant subspace approach. The self-similar property is interpreted in terms of invariance of the corresponding transfer function space to a given transformation in a Hilbert space, in a same way as the time invariance property for linear systems is related to the shift-invariance of the Hardy spaces. The transformation in question is exactly that defining the de Branges homogeneous spaces. The explicit form of the corresponding impulse response, which is shown to be described by a hyperbolic partial differential equation, is given.

17:30-18:00 **Boundary Observability in the Quasi-Static Thermoelastic Contact Problem**,
Michael Polis, Irina Sivergina
(Oakland University)
We study the observability properties of a system that models the temperature evolution of a thermoelastic rod that may come into contact with a rigid obstacle. The system dynamics are described by a one-dimensional nonlocal PDE of parabolic type with a nonlinear and nonlocal boundary condition. For a specified observation operator, we show the system to be observable and get the estimates for the boundary temperature and the current state of the system.

18:00-18:30 **Modeling Distributed Parameter Systems with Discrete Element Networks**,
Fabien Soulier, Patrick Lagonotte
(LET - ENSMA)
In this paper, we compare three general methods aimed to obtain reduced-order models of simple dis-

tributed parameter systems. We introduce the notion of infinite-order impedance and then we use the Mittag-Leffler theorem or the continued fraction expansion in order to represent models in the form of electrical networks. Eventually, the modeling of a cooling fin is taken as an example.

Room: 210, Session: TUP6

Chair: Avraham Feintuch
Title: **Robust and H-Infinity Control and Estimation**

16:30-16:50 **Simultaneous Robust Regulation and Robust Stabilization with Degree Constraint**,
Ryozo Nagamune (KTH)
This paper characterizes all controllers to a problem of simultaneous robust regulation and robust stabilization. The controller set will be represented in terms of a solution set to the boundary Nevanlinna-Pick interpolation problem. It is shown that a certain degree restriction on the solution set leads to a reasonable degree bound of controllers. Using the freedom in the controller set, other specification may be satisfied without increasing the controller degree.

16:50-17:10 **Closed-Loop Structure of Discrete-Time H-infinity Controller**,
Waree Kongprawechnon (Thammasat University), Shun Ushida, Hidenori Kimura (University of Tokyo)
This paper is concerned with the investigation of the closed-loop structure of an discrete-time H-infinity control system. It is shown that discrete-time H-infinity controller is represented, like Linear Quadratic Gaussian Control, as a pseudo state feedback, that is, a state feedback interconnected with an observer. However, in the discrete-time H-infinity control problem the control structure is more complicated since we cannot choose the state feedback and the observer independently.

17:10-17:30 **On a Recursive State-space Method for Discrete-time H_2-Approximation**,
Ralf Peeters (University of Maastricht), Martine Olivi (INRIA Sophia-Antipolis), Bernard Hanzon
The discrete-time H2-approximation problem for MIMO systems is reduced into an optimization problem over stable all-pass systems, for which a recursive state-space method is considered. A particular atlas of overlapping generic charts involving balanced realizations is used. It is shown that the gradient of the H2-criterion at any local optimum of order n-1 embedded in the boundary of a chart of systems of order n, is orthogonal to that boundary, pointing inwards.

17:30-17:50 **PID Robust Control via Genetic Algorithms and Integral Criteria Minimization**,
Catalin Nicolae Calistru, Oana Geman (Technical University of Iaşi, Romania)
No Abstract

17:50-18:10 **MIMO Systems Properties Preservation under SPR Substitutions**,
Juan Carlos Martinez-Garcia (Instituto Mexicano del Petróleo, G. Fernàndez-Anaya (University Iberoamericana)
This paper tackle the preservation of positive real properties in Multi-Input Multi-Output transfer functions, when performing substitutions of the Laplace variable s by strictly positive real functions of relative degree equal to zero. We consider also the preservation of stability properties of a class of unforced linear time-invariant systems affected by a memoryless, possibly time-varying nonlinear, input which depends on the system output.

18:10-18:30 **State Feedback Mixed H2/H-Infinity Problem for Linear Systems with Finite Jumps**,
Vasile Dragan, Adrian Stoica (Romanian Academy)
The paper consider the mixed H2/ H-infinity problem for linear systems with jumps. There are two main reults proved in the paper. The first one provides an evaluation of the norm induced by the inputs of exponentially stable systems with jumps. The second result gives the solution of the state feedback mixed H2/ H-infinity problem.

Wednesday August 14, 2002

8:00-9:00 *Room*: 101 Plenary Talk

J. William Helton (University of California San Diego)
Manipulating Matrix Inequalities Automatically
Matrix inequalities have come to be extremely important in systems engineering in the past decade. This is because many systems problems convert directly into matrix inequalities. Matrix inequalities take the form of a list of requirements that polynomials or rational functions of matrices be positive semidefinite. Of course while some engineering problems present rational functions which are well behaved, many other

problems present rational functions which are badly behaved. Thus taking the list of functions which a design problem presents and converting these to a nice form, or at least checking if they already have or do not have a nice form is a major enterprise. Since matrix multiplication is not commutative, one sees much effort going into calculations (by hand) on noncommutative rational functions. A major goal in systems engineering is to convert "noncommutative inequalities" to equivalent Linear Noncommutative Inequalities (that is, to LMI's), if possible. The talk concerns efforts to process "noncommutative inequalities" using computer algebra. The most basic efforts, such as determining when noncommutative polynomials are positive, convex, convertible to noncommutative LMI's, transformable to convex inequalities, etc., force one to a rich area of undeveloped mathematics.

9:00-10:00 *Room*: 101 Invited Talk

Jan C. Willems (University of Leuven, Belgium)
Dissipative Distributed Systems
This talk deals with systems described by constant coefficient partial differential equations. We start by introducing the behavior of such systems, controllability, and kernel and image representations. We then turn to dissipative systems. The main issue here is the construction of a storage function. This leads to an application of Hilbert's 17-th problem on the factorization of polynomials in many variables. Throughout the talk, we use Maxwell's equations as a running example for motivating the problems and the concepts. The research on which this talk is based, is joint work with Harish Pillai from the IIT Bombay.

9:00-10:00 *Room*: 102 Invited Talk

Albert-Laszlo Barabasi (University of Notre Dame),
The Architecture of Complexity: Emergence of Scaling in Complex Networks
Systems as diverse as the world wide web or the cell are described by networks with complex topology. Traditionally it has been assumed that these networks are random. However, recent studies indicate that such complex networks are the result of self-organizing processes governed by simple but generic laws, resulting in topologies strikingly different from those predicted by random networks. I will discuss the implications of these findings on the error and attack tolerance of the Internet, the robustness of the cells, and other properties of complex evolving networks.

9:00-10:00 *Room*: 136 Invited Talk

Knut Hueper (University of Würzburg, Germany),
The Dynamics of Matrix Eigenvalue Algorithms
We present a calculus approach to the convergence analysis of matrix eigenvalue algorithms including those methods as Jacobi, RQI, shifted QR, or Riccati iterations. New algorithms are developed, being somehow the true generalization of Rayleigh quotient iteration to full matrices, featuring cubic convergence on all eigenvectors simultaneously.

Morning:

Room: 102, Session: WA1
Chair: Raimund Ober
Title: **Immunology 3: Structure and Kinetics**

10:30-11:10 **Geometrical Methods in Structural Molecular Biology**,
Timothy F. Havel (MIT)
Structural molecular biology is concerned with the role played by the three-dimensional structures of DNA, proteins and other molecules in biochemical processes. A number of important problems in this field can be formulated in purely geometric terms, using lower and upper bounds on the interatomic distances to describe the sets of configurations of interest. The invariant theory of the Euclidean group, also known as distance geometry, is the basis of practical algorithms for computer- aided geometric reasoning with such distance constraints. This talk will describe the applications of these methods to protein homology modeling and structure determination by nuclear magnetic resonance spectroscopy.

11:10-11:50 **Kinetic aspects of TcR-MHC and Antibody-Antigen Interactions**,
Jefferson Foote (Fred Hutchinson Cancer Research Center)
Vertebrates develop immunity when they encounter a new microbe or foreign substance (antigen) because of a set of cells called lymphocytes. The immune reponse is a Darwinian process in which small numbers of antigen-recognizing lymphocytes are selected out of a vast pool of lymphocytes that don't recognize antigen. Each lymphocyte has on its surface unique antigen receptors whose molecular structure determines fitness of the lymphocyte in such a selection. One type of lymphocyte, a B cell, has a surface receptor called an antibody. When antigen is present, parameters governing these cells' fitness are the rate at which the antibody binds antigen (faster is better) and the lifetime of the antibody-antigen complex once it has formed (longer is better, up to a point). A second type

of lymphocyte, a T cell, has a surface antigen receptor called simply a T cell receptor (TCR). A TCR is structurally similar to an antibody, but is specialized to react with the complex formed by embedding an antigen fragment in a cellular molecule called a Major Histocompatibility Complex molecule (MHC). At an early stage of development, T cells that either don't bind MHC at all or bind it too tightly are eliminated. Fitness here, in advance of any antigen contact, depends on a weak interaction with MHC that potentially could be improved if an antigen fragment were present. Parameters subsequently governing fitness during an immune response are again rate of formation and lifetime of the TCR:(antigen+MHC) complex. Fast binding is probably an advantage, but a long lifetime is a distinct disadvantage. The optimal recognition signal occurs when a an antigen+MHC molecule engages a TCR for some threshold time, disengages, engages with another TCR on the same cell, disengages, and so on.

11:50-12:30 **Biophysical Considerations of T-Cell Receptor-Peptide/MHC Interactions**,
Brian M. Baker
No Abstract

Room: 126, Session: WA2
Chair: Martin Haenggi
Title: **Computer Networks**

10:30-10:50 **Min-Plus System Theory Applied to Communication Networks**,
Patrick Thiran, Jean-Yves Le Boudec
(EPFL)
Network Calculus is a set of recent developments, which provide a deep insight into flow problems encountered in networking. It can be viewed as the system theory that applies to computer networks. Contrary to traditional system theory, it relies on max-plus and min-plus algebra. In this paper, we show how a simple but important fixed-point theorem (residuation theorem in min-plus algebra) can be successfully applied to a number of problems in networking, such as window flow control, multimedia smoothing, and bounds on loss rates.

10:55-11:15 **Elements of Probabilistic Network Calculus for Packet Scale Rate Guarantee Nodes**,
Milan Vojnovic, Jean-Yves Le Boudec
(EPFL)
Packet Scale Rate Guarantee (PSRG) is a node model used by IETF for Expedited Forwarding, a priority service defined in the context of Differentiated Services. We review probabilistic performance bounds that apply to PSRG nodes, and improve a previous bound for loss probability.

11:20-11:40 **Statistical Performance Analysis of a Generalized Processor Sharing System by Using Large Deviations**,
Min Xie, Martin Haenggi
(University of Notre Dame)
This paper reviews the statistical performance analysis of the tail of the steady-state queue length distribution in a *Generalized Processor Sharing* (GPS) system. In particular, we focus on the *Large Deviations Principle* (LDP) which can be used to estimate a wide range of traffic sources, including short-range dependent sources, like processes with Markovian structure, and long-range dependent sources, like self-similar traffic. Generally, performance bounds, either upper or lower, are derived to characterize the asymptotic behavior of the queue length for each session which shares the GPS server with multiple sessions. Other analysis methods, such as service-curve based method, and bufferless fluid flow approximations are introduced briefly. Finally, a comparison of different methods and the range where they can be applied are given.

11:45-12:05 **Resource Allocation and Congestion Control in Distributed Sensor Networks - a Network Calculus Approach**,
Jinsong Zhang, Kamal Premaratne
(University of Miami)
Peter Bauer (University of Notre Dame)
The establishment of the overall objectives of a distributed sensor network is a dynamic task so that it may sufficiently well 'track' its environment.To integrately perform both resource allocation to each input data flow and congestion control at each decision node of such a network,a 'per-flow' virtual queuing framework that decouples the input data flows to each decision node is introduceded.Under this framework,network calculus notions are utilized to model the end-to-end flow and design a simple yet effective feedback control law for each input data flow.The control strategy is robust against the time-varying nature of network delays and buffer depletion rate,and source-node rate cutoff/saturation.

12:10-12:30 **Optimal Media Streaming in a Rate-Distortion Sense For Guaranteed Service Networks**,
Olivier Verscheure, Pascal Frossard
(IBM T.J. Watson Research Center),
Jean-Yves Le Boudec (EPFL)

We present an optimal low-complexity scheduling strategy of continuous media in a rate-distortion sense for guaranteed service networks. First we consider a stored and offline-compressed media stream. We give an explicit representation of the optimal smoothing strategy, which minimizes the required playback delay and decoding buffer size. Then we provide the theoretical bounds on the media rate such that (i) the optimal smoothing solution meets some constraints on the admissible playback delay and maximum decoding buffer size, and (ii) the media size is maximum. Finally we cast the rate-distortion problem as a piece-wise linear convex optimization algorithm, which is solved efficiently using state-of-the-art linear programming techniques.

Room: 129, Session: WA3

Chair: Eric Rogers
Title: **Minicourse B: Multidimensional Systems**

10:30-11:10 **Recent Results on Multidimensional Behaviors**,
Eva Zerz (University of Kaiserslautern, Germany)
In the behavioral framework, control is based on the interconnection of systems. We examine this approach and give some related results for behaviors that obey Oberst's duality. There is a close relation to the homological concept of extension modules. We will also address the question of causality, and we study first order representations of multidimensional behaviors.

11:10-11:50 **Motivation and General Concepts in Behavioral Systems**,
Jan C. Willems (University of Leuven, Belgium)
The aim of this introductory lecture is to outline tha basic philosophy that underlies the behavioral approach to modeling open dynamical systems. Special emphasis will be given to multi-dimensional systems. We will discuss some salient issues, such as kernel, image and latent variable representations, the elimination problem, and controllability.

11:50-12:30 **Similarities/Differences Between the Behavioral Approach for Multidimensional versus Delay-Differential Systems**,
Heide Gluesing-Luerssen,
(University of Oldenburg, Germany)
This presentation will focus on what the structural common ground between these the two different systems classes and why do the theories kind of diverge when it comes to the details.

Room: 136, Session: WA4

Chair: Paul Van Dooren
Title: **Model Reduction**

10:30-10:50 **An Overview of Model Reduction Methods for Large-Scale Dynamical Systems**,
Thanos Antoulas (Rice University)
No Abstract

10:50-11:10 **Analysis of Smith-Type Methods for Lyapunov Equations and Balanced Model Reduction**,
Dan Sorensen (Rice University)
No Abstract

11:10-11:30 **Krylov Subspace Techniques for Reduced Order Modeling of Nonlinear Dynamical System**,
Daniel Skoogh (Swedish Defence Research Agency), Zhaojun Bai (UC Davis)
We discuss reduced-order modeling of nonlinear dynamical systems by Krylov subspace methods. We focus on a method which the nonlinear system is first approximated by a bilinear system through Carleman bilinearization. A reduced-order bilinear system is constructed such that it matches certain number of multimoments corresponding to the first few kernels of the Volterra-Wiener representation of the bilinear system.

11:30-11:50 **Model Reduction of Second Order Systems**,
Younes Chahlaoui, D. Lemonnier, K. Meerbergen, A. Vandendorpe, P. Van Dooren
(Université Catholique de Louvain)
In this paper we look at model reduction of second order linear time-invariant system originating from mechanical systems. We propose several methods producing reduced order models of second order as well, since it makes sense to impose the reduced-order system to be of the same type than the original one.

11:50-12:10 **Model Reduction via Tangential Interpolation**,
Antoine Vandendorpe, K. Gallivan, P. Van Dooren
(Université Catholique de Louvain)
In this paper, we study the problem of model reduction of a state space system via tangential interpolation. We show that the problem has a unique solution if a particular Loewner matrix constructed from the data is nonsingular. Under these conditions the interpolating system can also be obtained as a projection of the original system. This is a generalisation of the

well known Multipoint Pade technique for tangential interpolation.

Room: 208, Session: WA5
Chair: Daniel Alpay, Yuli Eidelman
Title: **Time-Varying Systems and Numerical Problems**

10:30-11:00 **Unbounded J-inner Sections**,
Patrick Dewilde (Delft University of Technology),
Daniel Alpay (Ben-Gurion University of the Negev)
Rational J-inner-valued sections which are J-inner w.r. to the unit circle (J is a signature matrix) play an important role in interpolation theory and related theories for optimal signal recovery and optimal control. A now classical result is the extension of these theories to the time-varying context. These theories work with bounded J-inner operators, here we consider the unbounded case. It gives rise to new, interesting and intriguing results.

11:00-11:30 **Linear Time-Varying Darlington Synthesis**,
Avraham Feintuch (Ben-Gurion University)
No Abstract

11:30-12:00 **Reduction to System Methods for Inversion of Diagonal Plus Semiseparable Operator Matrices**,
Yuli Eidelman, Israel Gohberg (Tel-Aviv University)
We consider operator equations in a Hilbert space with a bounded linear operator represented by a finite operator matrix which is a sum of a diagonal and of a semiseparable operator matrices. We discuss three methods for solution of such equations which are based on reduction of the considering problem to a finite system of linear difference equations with boundary conditions. The obtained results yield new algorithms for solution of integral equations and for inversion of matrices.

Room: 209, Session: WA6
Chair: Erik Verriest
Title: **Nonlinear Systems and Control 4**

10:30-11:00 **Parameter Tuning of a Non Integer Order PID Controller**,
Luigi Fortuna, Riccardo Caponetto (University of Catania)
Domenico Porto (STMicroelectronics, Catania)
In this paper a new type of PID controllers is introduced and some properties are given. The novelty of the proposed controllers consists in the extension of derivation and integration order from integer to non integer numbers. This approach provides a more flexible tuning strategy and therefore an easier achieving of control requirements with respects to classical controllers.

11:00-11:30 **Nonlinear Discrete-Time Observer Design with Linearizable Error Dynamics**,
MingQing Xiao (Southern Illinois University at Carbondale),
Nikolaos Kazantzis (Worcester Polytechnic Institute),
Costas Kravaris (University of Patras),
Arthur J Krener (UC Davis)
A necessary and sufficient condition for the existence of a discrete-time nonlinear observer with linearizable error dynamics is provided. The necessary and sufficient condition derived is associated with the solvability of a nonlinear functional equation. A corollary is Siegel's theorem on the linearizability of a mapping. The method of observer design suggested by this theorem is constructive and can be applied approximately to any sufficiently smooth, linearly observable system yielding a local observer with approximately linear error dynamics.

11:30-12:00 **Analysis of Periodic Solutions of Tapping-Mode AFM: An IQC Approach**,
Murti Salapaka, Abu Sebastian
(Iowa State University)
The feedback perspective with the cantilever viewed as a linear system and the tip-sample interaction appearing as a nonlinear feedback is useful in analyzing AFM (Atomic Force Microscope) dynamics. Conditions for the existence and stability of periodic solutions for such a system when forced sinusoidally are obtained. These results are applied to the case where the AFM is operated in the tapping-mode. The near sinusoidal nature of periodic solutions is established by obtaining bounds on the higher harmonics. The concept of Integral Quadratic Constraints (IQC) is widely used in the analysis.

12:00-12:30 **Bifurcations of the Controlled Escape Equation**,
Tobias Gayer, (University of Augsburg)
In this paper we present numerical methods for the analysis of nonlinear autonomous control systems and two conditions, local accessibility and an inner-pair condition, under which they can be applied. These methods can be extended to work also for systems with time-periodic right hand side. In particular, the escape equation with sinusoidal driving term and additional control is analyzed. We will show that its

stability behavior undergoes interesting bifurcations when the range of the control influence is varied.

Room: 210, Session: WA7
Chair: Rodolphe Sepulchre
Title: **Discrete Event and Hybrid Systems**

10:30-10:50 **Switched Systems that are Periodically Stable may be Unstable**,
Jacques Theys, Vincent Blondel
(Catholic University of Louvain),
Alexander Vladimirov (Russian Academy of Science)
We prove the existence of pairs of matrices A0 and A1 with real entries that are such that all infinite periodic products of the two matrices converge to zero, but some infinite non-periodic product does not.

10:50:11:10 **The Servo Problem for Piecewise Linear Systems**,
Stefan Solyom, Anders Rantzer
(Lund Institute of Technology)
The servo problem for a wide class of nonlinear system is considered. A quantitative bound on system trajectories is derived. For piecewise linear systems the bound is shown to be computable in terms of linear matrix inequalities.

11:10-11:30 **Stability of Hybrid Control Systems Based on Time-State Control Forms**,
Yoshikatsu Hoshi, Mitsuji Sampei, Shigeki Nakaura
(Tokyo Institute of Technology)
Time-State Control Form was proposed as a control method for nonholonomic systems. This method needs input switching, so there is a drawback that the switching conditions may spoil the stability of the system. From the above backgrounds, this paper considers the stability of Time-State Control Form from the viewpoint of hybrid systems. We derive two kind of sufficient conditions which stabilize the systems by using Lyapunov functions.

11:30-11:50 **Discrete-Time Modeling and Analysis of Pulse-Width-Modulated Switched Power Converters**,
Willem L. De Koning, Jacob W. Van Der Woude, Yusuf Fuad
(Delft University of Technology)
The subject of this paper is a general theory for switched power converters, where the switch is pulse-width-modulated. The existence, uniqueness and stabi- lity of stationary solutions is investigated. Furthermore, feedback control situations are considered. It is shown that a running and fixed modulator, may invoke a very different behaviour of the feedback control system. Subharmonic oscillations are shown to be normal unstable behaviour.

11:50-12:10 **On the Control of the Resonant Converter: A Hybrid-Flatness Approach**,
Hebert Sira-Ramirez, Ramon Silva-Ortigoza
(CINVESTAV-IPN)
In this article we show that the series resonant DC/DC converter, which is a hybrid system, is piecewise differentially flat with a flat output which is invariant with respect to the structural changes undergone by the system evolution. This fact considerably simplifies the design of a switching output feedback controller that can be essentially solved by linear techniques. Flatness clearly explains all practical issues associated with the normal operation of the converter.

12:10-12:30 **Controllability of Periodically Switched Linear Systems with Delay in Control**,
Guangming Xie, Long Wang, Yijing Wang
(Peking University, Beijing)
The controllability for switched linear systems with time-delay in control are first formulated and investigated. A sufficient and necessary condition for controllability of periodically switched linear systems is presented. Furthermore, it is proved that the controllability can be realized in $n + 1$ periods at most. An example illustrates the above results. Some further results are also presented.

Middle:

Room: 102, Session: WM1
Chair: Raimund Ober
Title: **Immunology 4: Diffusion and Modelling**

14:00-14:40 **Measuring Lateral Diffusion and Associations of MHC Molecules in Membranes of the ER and at the Cell Surface**,
Michael Edidin (Johns Hopkins University)
No Abstract

14:40-15:20 **A Computational Model for T Cell Receptor Signal Integration**,
Mark Alber (University of Notre Dame),
Arancha Casal, Cenk Sumen, Tim Reddy, Mark Davis, Peter Lee
(Stanford University)
T cells play a central role in orchestrating the adaptive immune response. Specificity of T cells is defined by each cell expressing a unique population of

T cell receptors (TCRs) which interact with specific peptide-MHC (pMHC) on other cells, such as antigen-presenting cells (APC).XSCC During recognition, the T cell surface comes in direct contact with that of the APC. Within the first 30-60 seconds of contact, the T cell makes the critical decision to either sustain the interaction, eventually leading to activation, or to disengage and move on. Over this brief period, thousands of TCRs interact with thousands of different pMHCs with a wide range of affinities. The T cell must quickly survey and integrate this vast array of signals into its critical decision. Learning how a T cell perceives this vast, heterogeneous repertoire is critical to understanding not only T cell biology, but also certain disease evasion mechanisms. Mathematical models and computer simulations can help overcome experimental limitations. If biologically-sound and well-informed, a computational model such as the one we propose here can result in valuable insights into the T cell recognition process.

15:20-16:00 **Immunological Synapse Formation: A Crossroad of Physical Chemistry and Cell Biology**,
Arup K. Chakraborty
(University of California, Berkeley)
No Abstract

Room: 126, Session: WM2

Chair: Aleksandar Kavcic
Title: **Control and Communications**

14:00-14:20 **Feedback Capacity**,
Sekhar Tatikonda, Sanjoy Mitter
(MIT)
In this paper we provide a general framework for characterizing the capacity of a large variety of channels with memory, side-information, intersymbol interference, and feedback. For Markov channels we show that one can formulate the capacity optimization problem as a dynamic program and compute the capacity using tools from approximate dynamic programming. Feedback codes are then discussed.

14:20-14:40 **Sum-Product Algorithm and Feedback Capacity**,
Shaohua Yang, Aleksandar Kavcic
(Harvard University)
In this paper, we explore the link between the sum-product algorithm and the feedback capacity of a channel with memory. We show that the optimal (i.e., capacity-achieving) feedback is captured by the causal posterior state probabilities. For finite-state machine channels, the optimal feedback is captured by the forward recursion of the sum-product (Baum-Welch, BCJR) algorithm. This result drastically reduces the space over which the optimal feedback-dependent source distribution needs to be sought. Further, the feedback capacity computation may then be formulated as an average-reward-per-stage stochastic control problem, for which numerical solutions of Bellman's equation deliver the feedback-capacity-achieving source distribution. With the knowledge of the capacity-achieving source distribution, the value of the capacity is easily estimated using accurate Markov chain Monte Carlo methods. We demonstrate the applicability of the method by computing the feedback capacity of partial response channels and the feedback capacity of run-length-limited (RLL) sequences over binary symmetric channels (BSCs).

14:40-15:00 **Kalman Filtering, Factor Graphs, and Electrical Networks**,
Pascal O. Vontobel, Dani Lippuner,
Hans-Andrea Loeliger
(ETH)
Factor graphs are graphical models with origins in coding theory. It is well known that Kalman filtering is an instance of the generic sum(mary)-product algorithm on the corresponding factor graph. In this paper, a one-to-one correspondence between such factor graphs and a class of electrical networks is presented. The electrical network "computes" correct Bayesian estimates even for factor graphs with cycles.

15:00-15:20 **Kalman Filtering Applied to Timing Recovery in Tracking Mode**,
Panu Chaichanavong (Stanford University)
Brian Marcus (IBM Almaden)
This paper investigates the performance of the Kalman filter as a timing recovery system in tracking mode, subject to a wide range of operating conditions. Our simulation compares the Kalman filter and the phase-locked loop based on the number of divergences for various values of timing disturbance and SNR. They are shown to work equally well in low SNR and disturbance. However, the Kalman filter outperforms the phase-locked loop when both SNR and disturbance are high. The simulation also suggests that the Kalman filter is more robust to variations in operating conditions.

15:20-15:40 **Lower Bounds for the Performance of Iterative Timing Recovery at low SNR**,
Aravind Nayak, J. Barry, S. McLaughlin
(Georgia Institute of Technology)
We consider the problem of timing recovery at low signal-to-noise ratio. We first derive a lower bound for

the timing estimation error variance in the presence of a random walk timing jitter, for the PR-IV channel. Then, we look at the trained phase-locked loop, which gives a hueristic lower bound for the performance of iterative timing recovery schemes involving phase-locked loops.

15:40-16:00 **Classical Capacity of Quantum Channels**,
Navin Khaneja (Harvard University)
No Abstract

Room: 129, Session: WM3

Chair: Krzystof Galkowski, Eric Rogers, Victor Vinnikov
Title: **Multidimensional Systems 3**

14:00-15:00 **Conservative Multidimensional Systems: A Survey**,
Joseph A. Ball (Virginia Tech)
We survey a number of classes of ISO systems for which an energy balance relation holds. Such systems lead to transfer functions with membership in various types of multivariable generalizations of the classical Schur class, including holomorphic functions of several variables, bundle maps between bundles over a Riemann surface and formal power series in noncommuting indeterminates. Connections with Lax-Phillips scattering in this context will also be discussed.

15:00-15:30 **On J-Conservative Scattering nD System Realizations**,
Dmitry Kalyuzhniy-Verbovetzky
(The Weizmann Institute of Science)
We extend the notion of discrete conservative scattering nD system to the case where its state space is endowed with the structure of a Krein space by means of a canonical symmetry J. We call such systems J-conservative. We prove that any operator-valued function holomorphic on some neighbourhood of the origin in the complex space of n variables and vanishing at the origin has a J-conservative scattering nD system realization.

15:30-16:00 **Factorization of M-D Polynomial Matrices for Design of M-D Multirate Systems**,
Mikhail Tchobanou (Moscow Technical University),
Cynthia Woodburn (Pittsburg State University)
The problem of the design of effective 2-D and 3-D multirate systems with prescribed properties is considered using tools from commutative algebra. Results for factoring 2-channel polyphase matrices are presented. After such a factorization, the number of computations may be reduced. For a 3-channel multirate system, an algorithmic version of Suslin's stability theorem may be useful for factoring the polyphase matrices.

Room: 136, Session: WM4

Chair: Uwe Helmke
Title: **Control and Computation**

14:00-14:30 **Continuation of Eigendecompositions**,
Luca Dieci (Georgia Tech)
In this talk we discuss the problem of smooth continuation of eigendecompositions. In particular, we discuss the cases of the Schur decomposition and of bi-diagonal form. Connected to these, we discuss continuation of Hessenberg forms. This is joint work with A. Papini, Univ. of Florence.

14:30-5:00 **Numerical Solution of Euclidean Balanced Norm Realizations via Gradient Flows**,
N. Del Buono, L. Lopez
No Abstract

15:00-15:30 **Controllability of the QR Algorithm on Hessenberg Flags**,
Uwe Helmke, Jens Jordan
(University of Würzburg)
The shifted QR algorithm can be interpreted as a nonlinear discrete dynamical system on the flag manifold. In the complex case we describe the reachability sets as orbits of a group action and prove non-controllability of the algorithm. In contrast, the algorithm restricted on the subset of Hessenberg flags is generically controllable.

15:30-16:00 **The Continuos-Time Rayleigh Quotient Flow on the Grassmann Manifold**,
Rodolphe Sepulchre, P.-A. Absil
(University of Liege),
R. Mahony (Australian National University)
An extension of the Rayleigh quotient iteration (RQI) to the Grassmann manifold has been recently proposed for computing a p-dimensional eigenspace of a symmetric matrix A. Here we analyze a continuous-time flow analogous to this Grassmannian RQI. This flow achieves deflation in finite time, i.e. it converges in finite time to a subspace that includes an eigenvector of A.

Room: 209, Session: WM5

Chair: Anthony Bloch
Title: **Algebraic and Differential Geometry in Systems Theory**

14:00-14:20 **Hamiltonian Structure of the Algebraic Riccati Equation and its Infinitesimal V-Stability**,
Nanaz Fathpour, Edmond A. Jonckheere
(University of Southern California)
We will investigate the stability behavior of quadratic maps in higher dimensions. We will establish the connection between infinitesimal V-stability of solutions to the Algebraic Riccati Equations, and the Hamiltonian eigenstructure of the solutions. Infinitesimal V-stability of critical points of the Riccati map is crucially related to stability of the Riccati map. Grobner Bases are used to implement the calculations.

14:20-14:40 **Global Transformation of Nonlinear Dynamic Systems into Canonical Forms**,
Anna Michtchenko, Aleksey Zhirabok
(Far Eastern State University)
The problem of transformation of nonlinear systems into canonical forms is studied. Both continuous-time and discrete-time cases are considered. Sufficient and necessary conditions for such transformation are obtained. A special mathematical technique (so-called the algebra of functions) is used.

14:40-15:00 **A Lie-Group Approach for Nonlinear Dynamic Systems Described by Implicit Ordinary Differential Equations**,
Kurt Schlacher (University of Linz),
Andreas Kugi (University of Saarland),
Kurt Zehetleitner (University of Linz)
This contribution presents a Lie-group based approach for the accessibility and the observability problem of dynamic systems described by a set of implicit ODEs. It is shown that non-accessible or non-observable systems admit Lie groups acting on their solutions such that distinguished parts of the system remain unchanged. The presented methods use the fact that the dynamic system may be identified with a submanifold in a suitable jet-bundle.

15:00-15:20 **Quotients of Fully Nonlinear Control Systems**,
Paulo Tabuada, George J. Pappas
(University of Pennsylvania)
In this paper, we define and study quotients for fully nonlinear control systems. Our definition is inspired by categorical definitions of quotients as well as recent work on abstractions of affine control systems. We show that quotients always exist under mild regularity assumptions, and characterize the structure of the quotient control bundle. We also introduce a notion of projectability which turns out to be equivalent to controlled invariance. This allows to regard previous work on symmetries, partial symmetries, and controlled invariance as leading to special types of quotients. We also show the existence of quotients that are not induced by symmetries or controlled invariance.

15:20-15:40 **The Wave Equation as a Port-Hamiltonian System, and a Finite Dimensional Approximation**,
Viswanath Talasila, Goran Golo, Arjan van der Schaft
(University of Twente)
The problem of approximating a distributed parameter system with free boundary conditions is solved for the 2-dimensional wave equation. To this end we first model the wave equation as a distributed-parameter port Hamiltonian system. Then we employ the idea that it is natural to use different finite elements for the approximation of different geometric variables (forms) describing a distributed-parameter system, to spatially discretize the system and we show that we obtain a finite-dimensional port-Hamiltonian system, which also preserves the conservation laws.

15:40-16:00 **Pseudo Balancing for Discrete Nonlinear Systems**,
Erik Verriest (Georgia Institute of Technology)
A rationale is presented to extend the notion of a balanced realization to nonlinear discrete time systems However, it is shown that even with a set of very reasonable assumptions, it is not possible to construct a globally balanced realization. The obstruction stems from certain integrability conditions which are generically not satisfied. One way around this is to relax the requirements of global balancing by restricting the balancedness conditions to a discrete set of points in the state space.

Room: 210, Session: WM6

Chair: Panos Antsaklis, Anthony Michel
Title: **Hybrid Control System Analysis, Synthesis and Diagnosis**

14:00-14:30 **Partial Stability of Dynamical Systems**,
Ye Sun, A.P. Molchanov, A.N. Michel
(University of Notre Dame)
We develop new results for partial stability of general dynamical systems with respect to invariant sets defined on metric space, using stability preserving map-

pings. Our results are applicable to a much larger class of systems than existing results, including to dynamical systems that cannot be determined by the usual classical (differential) equations. Furthermore, in contrast to existing results which pertain primarily to the analysis of equilibria, the present results apply to invariant sets (including equilibria as a special case). We apply our results in the analysis of a class of discrete event systems (a computer load balancing problem).

14:30-15:00 **An Approach to General Switched Linear Quadratic Optimal Control Problems with State Jumps**,
Xuping Xu (Penn State Erie),
Panos Antsaklis (University of Notre Dame)
Unlike conventional optimal control problems, optimal control problems of switched systems require the solutions of not only the optimal continuous inputs but also the optimal switching sequences. In a previous paper by the authors, an approach for an important class of switched systems optimal control problems, namely, general switched linear quadratic (GSLQ) problems where each subsystem is linear and the cost functionals are in general quadratic forms, was reported. In this paper, we extend the approach to GSLQ problems with state jumps at the switching instants. For such problems, the cost functionals include not only the general quadratic cost terms for the state and the input but also the costs for state jumps. The approach in this paper allows us to derive the derivatives of the optimal cost with respect to the switching instants based on the solution of the discontinuous Riccati equation parameterized by the switching instants along with its differentiations. With the knowledge of the derivatives, nonlinear optimization methods can be applied to locate the optimal switching instants. An example is provided to illustrate the approach.

15:00-15:30 **The Controlled Composition Analysis of Hybrid Automata**,
Ying Shang, M.D. Lemmon
(University of Notre Dame)
This paper presents a sufficient condition for the existence of global non-terminating solutions in controlled hybrid automata. The condition is based on a recursive algorithm that can always terminate after a finite number of iterations to a limit set of states called the inner viability kernel. The inner viability kernel is easily computed in some cases. The inner viability approach can ensure the composition analysis of controlled hybrid automata.

15:30-16:00 **Monitoring and Diagnosis of Hybrid Systems Using Particle Filtering Methods**,
Xenofon Koutsoukos, James Kurien, Feng Zhao
(Palo Alto Research Center)
Embedded systems are composed of a large number of components that interact with the physical world via a set of sensors and actuators, have their own computational capabilities, and communicate with each other via a wired or wireless network. Diagnostic systems for such applications must address new challenges caused by the distribution of resources, the networking environment, and the tight coupling between the computational and the physical worlds. Our approach is to move from centralized, discrete or continuous techniques toward a distributed, hybrid diagnosis architecture. Monitoring and diagnosis of any dynamical system depend crucially on the ability to estimate the system state given the observations. Estimation for hybrid systems is particularly challenging because it requires keeping track of multiple models and the transitions between them. This paper presents a particle filtering based estimation algorithm that addresses the challenge of the interaction between continuous and discrete dynamics in hybrid systems. The hybrid estimation methodology has been demonstrated on a rocket propulsion system.

Room: 208, Session: WM7
Chair: Giorgio Picci
Title: **Stochastic Systems 2**

14:00-14:30 **State Space Realization of Random Processes with Feedback**,
Giorgio Picci, Alessandro Chiuso
(University of Padova)
Construction of the state space of a stochastic process with exogenous inputs when feedback may be present.

14:30-15:00 **Approximate Realization of Hidden Markov Chains**,
Lorenzo Finesso (LADSEB-CNR, Padova)
Peter Spreij (University of Amsterdam)
No Abstract

15:00-15:30 **Random Sampling of a Continuous-Time Stochastic Dynamical System**,
Mario Micheli, Michael I. Jordan
(Brown University)
We consider a dynamical system where the state equation is given by a linear stochastic differential equation and noisy measurements occur at discrete times, in correspondence of the arrivals of a Poisson process. After formulating a Kalman Filter-based state estimation algorithm, we compute a complete statistical

description of the state estimation error process and analyze its dependence on the continuous-time system's dynamics and the sampling rate.

15:30-16:00 **The Hilbert Space of an Ergodic Sequence**,
Giorgio Picci, (University of Padova)
Tom Taylor (Arizona State University)
Given a semi infinite time series, it has been shown that under some natural assumptions of existence of limits of certain time averages, an essentially unique stationary stochastic process exists which produces the observed trajectory according to the classical "urn" scheme of probability theory.

Afternoon:

Room: 102, Session: WP1

Chair: Raimund Ober
Title: **Immunology 5: Cellular Aspects**

16:30-17:30 **Staining Antigen Specific CD4+ T -Cells with Class II MHC Oligomers**,
Lawrence Stern (MIT)
No Abstract

17:10-17:40 **The Roles of Serial Engagement and Kinetic Proofreading in Peptide-Induced T-Cell Activation**,
Dan Coombs, Carla Wofsy, Byron Goldstein
(Los Alamos National Laboratory)
The activation of a T-cell requires the formation of a long-lived attachment to an antigen-presenting cell (APC). APCs present peptide on their surfaces, held by a major-histocompatibility complex (MHC). A given T-cell carries receptors (TCRs) specific for a particular MHC-peptide group, along with other less specific adhesion and costimulatory molecules. The stable region of close apposition (immunological synapse) may facilitate signal transduction, by concentrating the TCR and MHC-peptide together and allowing long-lived bond formation. A TCR will become activated if it can form a sufficiently long-lived bond to allow multiple biochemical changes to occur (the kinetic proofreading hypothesis). We have developed a mathematical model to examine the TCR-MHC-peptide interaction within the stable region and use it to study (1) the competing effects of serial engagement (sequential activation of TCR by one MHC-peptide) and kinetic proofreading, and (2) the possible role of TCR oligomerization in activation of T-cells. In conjunction with the model, recent experimental data indicates that activated TCR must remain active for a period after dissociation from MHC-peptide. Recent extensions of the model to deal with other situations will also be presented.

Room: 126, Session: WP2

Chair: Roxana Smarandache
Title: **Cryptography**

16:30-17:00 **A High-Speed Processing for RSA Cryptograms Using High-Radix Signed-Digit Numbers and a New Algorithm of Modulo Operation**,
Yoshinori Fujisawa, Yasushi Fuwa
(Nagano National College of Technology)
In this work, we developed a high speed LSI for encoding and decoding the RSA cryptogram and describe the processing method in this paper. In this paper, we proposed two new processing algorithms for an RSA public key cryptogram system. Then, we developed LSI to realize our proposed algorithm using a sequential processing algorithm for calculating remainders. As a result, it was clear that the method using our proposed algorithm works faster than the previous method.

17:00-17:30 **On the Rational Cubic Curve Cryptosystems**,
Xiaochang Wang, Heather Henkel
(Texas Tech University)
In this paper, we study the group on the finite field of q elements plus infinity induced by rational cubic curves. We show that the group is isomorphic to either a subgroup of order q+1 of the multiplicative group of the finite field of q square elements, or the additive group, or multiplicative group, of the original field.

17:30-18:00 **Public Key Cryptography Based on Simple Modules over Simple Rings**,
Gerard Maze(EPFL),
Christopher Monico (University of Notre Dame),
Joan-Josep Climent (University of Alicante),
Joachim Rosenthal (University of Notre Dame)
We show how the action of a (semi)ring on a (semi)module gives rise to a generalized Diffie-Hellman protocol. This leads naturally to a cryptographic protocol whose security relies on a finite version of a difficult control problem - steering the state of a dynamical system from an initial vector to some final location.

Room: 129, Session: WP3

Chair: Krzystof Galkowski, Eric Rogers, Victor Vinnikov
Title: **Multidimensional Systems 4**

16:30-17:00 **Spatial Restoration with Reduced Boundary Error**,
Nirmal Bose, Jaehoon Koo
(The Pennsylvania State University)
Since any symmetric **BTHTHB** matrix can be diagonalized by the **DCT** matrix, a **BTTB** matrix encountered in the image reconstruction problem is sometimes approximated by a **BTHTHB** matrix for computational efficiency. In this paper, the error caused by the approximation of a **BTTB** matrix by a **BTHTHB** matrix is analyzed. It is also shown that a simple modification of the observed image can achieve both reduced boundary error and fast deblurring.

17:00-17:30 **On Succesive Packing Approach to Multidimensional (M-D) Interleaving**,
Sankar Basu (IBM T. J. Watson Research Center), Xi Min Zhang, Yun Q. Shi
(New Jersey Institute of Technology)
We propose an interleaving scheme for multidimensional (M-D) interleaving. To achieved byusing a novel concept of basis interleaving array. A general method of obtaining a variety of basis interleaving arrays is presented. Based on the basis interleaving array, we then propose an interleaving technique, called successive packing, to generate the interleaved array of arbitrary size. It is shown that the proposed technique can spread any error burst of $m_0^k \times m_1^k$ within $m_0^n \times m_1^n$ array $(1 \leq k \leq n-1)$ effectively so that the error burst can be corrected with simple random error correcting-code (provided the error correcting-code is available). It is further shown that the technique is optimal for combating a set of arbitrarily-shaped error bursts. Since this algorithm needs to be implemented only once for a given M-D array, the computational cost is is low.

17:30-18:00 **Matrix Functions in Homomorphic Signal Processing**,
Eduard Krajnik (Czech Technical University)
Yamada et al. suggested replacing the traditional cepstrum operator used in homomorphic signal processing by a finite-dimensional alternative called isomorphic operator. This paper sheds another light on the isomorphic operator in terms of two matrix functions: exponential and logarithm. Closed form formulas for 1–D and 2–D cases are presented.

18:00-18:30 **Cellular Automata in Image Processing**,
Adriana Popovici, Dan Emanuel Popovici
(University of the West Timisoara, Romania)
Cellular automata can be successfully applied in image processing. In this paper we discuss the application of two-dimensional cellular automata to the problems of noise removal and border detection in digital images. The proposed methods are compared with some classical or recent methods. A very important feature of the proposed methods is their intrinsic parallelism, since they are implemented on well-known parallel-working machines, as cellular automata are.

Room: 136, Session: WP4
Chair: Biswa Nath Datta, Floyd B. Hanson
Title: **Large-Scale Computations in Control**

16:30-16:50 **Projection Methods for Reduced Order Modeling with Guaranteed Stability**,
Thanos Antoulas (Rice University)
No Abstract

16:55-17:15 **Computational Methods for Portfolio and Consumption Policy Optimization in Log-Normal Diffusion, Log-Uniform Jump Environments**,
Floyd B. Hanson (University of Illinois at Chicago), J. J. Westman (UCLA)
Computational methods for a jump-diffusion portfolio and consumption policy optimization application using a log-uniform jump distribution with the usual log-normal diffusion are considered. Jump-diffusion parameter estimations from a companion stochastic theory paper are applied for more model realism. The computational complexity of stochastic dynamic programming is reduced by the canonical Constant-Relative-Risk-Adverse utility model.

17:20-17:40 **Partial Eigenvalue Assignment in Linear Systems: Existence, Uniqueness and Numerical Solution**,
Biswa N. Datta (Northern Illinois University), Daniil R. Sarkissian (Mississippi State University)
The problem of reassigning a part of the open-loop spectrum of a linear system by feedback control, leaving the rest of the spectrum invariant, is called the partial eigenvalue assignment problem. In this paper, we derive new necessary and sufficient conditions for existence and uniqueness of solution of the partial eigenvalue assignment problem and then present a practical parametric algorithm to numerically solve it. The algorithm is feasible for large-scale solution and computationally viable. It also offers an opportunity to devise a robust solution to the problem by exploiting the arbitrary nature of the parameters.

17:45-18:05 **Model Reduction via an Explicitly Restarted Lanczos Algorithm**,
Vasilios Papakos, Imad M. Jaimoukha
(Imperial College,London)
The nonsymmetric Lanczos algorithm, which belongs to the class of Krylov subspace methods, is increasingly being used for model reduction of large scale systems in state space form, to exploit the sparse structure and reduce the computational burden. However, a good approximation is, usually, achieved only with relatively high order reduced models. Moreover, the computational cost of the Lanczos algorithm is dominated by the full rebiorthogonalization procedure, which is necessary because the Lanczos vectors tend to lose their biorthogonality. A method based on linear fractional transformations (LFTs) is proposed to compute a reduced mth order model by applying k small Lanczos algorithms with m/k steps each; thus reducing the computational cost and storage requirements. Applying this method, one can compute a tridiagonal similar realization of f(s) and when combined with conventional model reduction techniques, a minimal or reduced realization.

Room: 208, Session: WP5

Chair: J. William Helton
Title: **Expressing Polynomials as Sums of Squares Together with Applications**

16:30-17:10 **How to Write a Polynomial as a Sum of Squares of Polynomials, and Why You'd Want to Do So**,
Bruce Reznick (University of Illinois)
A fundamental question about a real polynomial is whether it takes only non-negative values. If the polynomial is a sum of squares of polynomials, then the answer to this question is "yes". Recent advances in implementing an old algorithm via semidefinite programming allow one to answer the "sum of squares" question rapidly. (This is connected to Hilbert's 17th Problem.) The talk will be expository, light on abstraction and filled with concrete examples.

17:10-17:30 **Applications of Our Newfound Facility in Expressing Polynomials as Sums of Squares.**,
Pablo A. Parrilo (ETH)
No Abstract

17:30-17:50 **Reduced Representations of Positive Polynomials**,
Mihai Putinar (UC Santa Barbara)
It is known from Emil Artin's theory of ordered fields that a positive polynomial on a semi-algebraic set can be written as a sum of squares of rational functions, with some control over the form of the denominators. By using methods of operator theory (subnormal tuples, hereditary calculus, moment problems) we will describe two possible simplifications in Artin's representation: a reduction from the multiplicative cone generated by the defining polynomials of the support set to the additive cone, and a reduction from real variables in an even dimensional space to complex ones. An altenative, purely algebraic approach to the first simplification was recently obtained by T.Jacobi and A.Prestel.

17:50-18:10 **Recent Progress in Polynomial Optimization**,
Ruchira Datta (UC Berkeley)
No Abstract

18:10-18:30 **Bounding Linear PDEs via Semidefinite Optimization**,
Constantine Caramanis, Dimitris Bertsimas
(MIT)
We apply some recent results of algebraic geometry, to show how the underlying geometry of an optimization problem may be incorporated in a natural way, in a semidefinite optimization formulation. We discuss two examples; the first, an application to partial differential equations, and the second, an application to deriving optimal inequalities in probability theory. Both illustrate the strength of the geometry induced constraints.

Room: 209, Session: WP6

Chair: Viswanath Ramakrishna
Title: **Quantum Engineering II**

16:30-17:10 **Optimal Control of Laser Cooling: A Theory of Purity Increasing Transformations**,
David Tannor, Shlomo Sklarz
(The Weizmann Institute)
The powerful techniques of Optimal Control Theory (OCT), used in recent years for a variety of quantum mechanical problems are applied to the problem of laser cooling in molecules. This is a striking new mechanism in which the system does not lose energy at intermediate times, but grows more coherent; only at the end of the process is the coherent or pure state manipulated into the lowest energy state. The key components of the theory – the definition of cooling as purity increase; the invariance of the purity to control fields; and a closed form for the optimal cooling trajectory – correspond to the zeroth, second and third laws of thermodynamics, filling a longstanding need for thermodynamic formulation of laser cooling.

17:10-17:30 **Controllability of Pairs of Coupled Quantum Dots**,
Viswanath Ramakrishna
(University of Texas at Dallas)
This article studies the controllability of a pair of coupled quantum dots being interrogated by an external electromagnetic field. It is shown that this system is controllable. However, in the limit of large spatial separation between the two dots the dynamical Lie algebra of the problem degenerates to the complex representation of $so(4)$ in $su(4)$. The question of which pure and mixed states for the system are accessible from the initial condition is then studied via an ab initio approach. This is achieved by finding an explicit conjugation, within $su(4)$, between the complex representation of $so(4)$ and $su(2) \otimes su(2)$, and then using the greater structure of the group $SU(2) \otimes SU(2)$.

17:30-17:50 **Constructive Control of Quantum Systems**,
Sonia Schirmer, A.D. Greemtree
(Open University, Milton Keynes)
The problem of explicit generation of unitary operators for atomic systems with degenerate energy levels is considered. The Lie algebra structure is used to derive control schemes for the creation of arbitary superposition states and selective population interchanges for a transition between two three-fold degenerate energy levels.

17:50-18:10 **Use of Wei-Norman Formulae and Parameter Differentiation in Quantum Control**,
Claudio Altafini (SISSA-ISAS)
For the unitary operator, solution of the Schrodinger equation corresponding to a time-varying Hamiltonian, the relation between the Magnus and the product of exponentials expansions can be expressed in terms of a system of first order differential equations in the parameters of the two expansions, often referred to as Wei-Norman formula. It is shown how to use Wei-Norman formulae for the purposes of quantum computing.

18:10-18:30 **Control of Quantum Mechanical Systems with Minimum Number of Switches**,
Domenico D' Alessandro (Iowa State University)
Given two linearly independent skew symmetric matrices every rotation matrix can be written as the product of alternate elements from the corresponding one dimensional subgroups. In this talk, we evaluate the minimum number of factors required for the factorization of a given rotation matrix and provide an algorithm to determine the factors in the optimal factorization explicitly. The results can be applied to the bang bang control with minimum number of switches of two level quantum systems. We also discuss the general problem of uniform finite generation of compact Lie groups.

Thursday August 15, 2002

8:00-9:00 *Room*: 101 Plenary Talk

Eduardo Sontag (Rutgers University)
On Systems Molecular Biology and Control Theory
We discuss some of the central topics in "systems" ("post-genomic") molecular biology, and how some of the basic concepts and ideas of control theory might help in understanding basic issues such as feedback, stability, systems identification, and switching. While problems in this new and exciting field "sound" similar to standard problems in control theory, the technical details are often different enough so as to present totally new theoretical challenges.

9:00-10:00 *Room*: 126 Invited Talk

Olof Staffans (Abo Akademi University),
Passive and Conservative Infinite-Dimensional Impedance and Scattering Systems (from a Personal Point of View)
A system is conservative if both the system itself and its dual system preservs energy. It is passive if it does not contain any internal energy sources. The words scattering and impedance in the title describe how the system interacts with its surroundings, i.e, it defines the meaning of the word "energy". We present the basic theory for discrete and continuous time linear infinite-dimensional systems which are impedance or scattering passive or conservative. We also describe how to go from continuous time to discrete time and back (using the Cayley transform), and from an impedance to a scattering setting (using a modified feedback transform). We point out that every contractive analytic function in the right half-plane has a continuous time scattering conservative realization, and that most positive (real) functions in the right half-plane have a continuous time impedance conservative realization. We finally say a few words about lossless systems (i.e., systems which do not contain internal energy sources, sinks, or traps).

9:00-10:00 *Room*: 129 Invited Talk

Wolfgang J. Runggaldier (LADSEB-CNR Padova)
On Stochastic Control in Finance
In this talk we shall review various financial applications of stochastic control as well as appropriate solution methodologies. These methodologies will furthermore be discussed in comparison with one another.

9:00-10:00 *Room*: 136 Invited Talk

Matthias Heinkenschloss (Rice University)
Domain Decomposition Approaches for the Optimization of Distributed Systems
Optimization of distributed systems in the context of parameter estimation, optimal control, or optimal design plays an important role in science and engineering. These optimization problems pose several computational difficulties arising, among other things, from the large number of variables and the conditioning of subproblems. Domain decomposition (DD) can be applied at different levels (formulation of the distributed optimization problem, solution of optimization subproblems, and computation of PDE solutions) to design efficient optimization algorithms for distributed systems. In this talk we study several DD approaches, discuss relations among them, and present applications to selected problems.

Morning:

Room: 102, Session: THA1

Chair: Mark Alber
Title: **Complex Networks and Biological Applications 1**

10:30-11:10 **The Spread of Infections on Social Networks**,
Mark Newman (University of Michigan)
One of the primary motivations for the study of social networks has been the role they play in the spread of infection. In this talk I will describe some recent work on the modeling of epidemic disease on networks. Among other things, I will discuss what we know about the structure of actual contact networks and describe some exact solutions we have found of epidemic models on networks of various kinds.

11:10-11:50 **Information Theory Aspects of Signal Transduction and Gene Regulation**,
Andrea Levchenko (Johns Hopkins University)
Intracellular signal transduction is the process of transmission and processing of information supplied by the state of the medium surrounding a cell or directly by the neighboring cells. Recent progress in genetics, recombinant DNA technology and single molecule imaging has resulted in elucidation of the structure of signaling pathways and regulatory mechanisms used in gene expression. Biochemically based mathematical and computational models are becoming a common useful tool in understanding the systemic control characteristics of the coupled signaling and gene regulation networks. However, no attempt has been made so far to develop a description suitable for using the concepts of Shannon's information theory and to utilize this description of signaling events to follow the information flow. Here I will propose a way, in which a representation of information flow can be established and used in two well-defined biological settings involving regulation of gene expression in stress response and development. Implications of this analysis for a conceptually different understanding of biological regulation will be discussed.

Room: 126, Session: THA2

Chair: Ruth Curtain, Olof Staffans
Title: **Distributed Parameter Systems: Theory Part I**

10:30-10:50 **Some Results on the Theory of Linear Time-Invariant Dissipative Systems with Hilbert and Pontryagin State Spaces**,
Damir Arov
(South Ukranian Pedagogical University)
New results on the similiraty of dissipative linear time-invariant systems and main operators of the systems with Hilbert and Pontryagin state spaces will presented.They retate to the systems with transfer functions of generalized Schur, Caratheodory and Potafov classes

10:55-11:15 **Explicit Formulae for J-Spectral Factors for Well-Posed Systems**,
Ruth Curtain (University of Groningen),
Amol J. Sasane (University of Twente)
The standard way to obtain explicit formulas for spectral factorization problems for rational transfer functions is to use a minimal realization and then obtain formulae in terms of the generators A, B, C and D. It is only possible to extend this approach to special classes of infinite-dimensional systems. For the class of well-posed linear systems for which zero is in the resolvent set of A we suggest another approach. There are nice connections between well-posed linear systems and their reciprocal systems which allow one to translate a factorization problem for the well-posed linear system into one for its reciprocal system, the latter having bounded generating operators. We illus-

trate this general approach by giving explicit solutions to the sub-optimal Nehari problem.

11:20-11:40 **A Riccati Equation Approach to the Standard Infinite-Dimensional H-Infinity Problem**,
Kalle M. Mikkola (Helsinki University of Technology), Olof Staffans (Abo Akademi University)
We study the standard (four-block) H-infinity problem in the infinite-dimensional setting of regular well-posed linear systems, and show that the standard characterizations of the solvability of this problem in terms of either two independent Riccati equations and a spectral radius condition or two nested Riccati equations are valid. We are also able to parameterize the set of all suboptimal solutions in the standard way. The exact formulation varies depending on the regularity assumptions that we make. Pure delays in the impulse response are permitted in the most general version, but these lead to certain correction terms in the Riccati equations.

11:45-12:05 **Sub-optimal Hankel Norm Approximation for the Wiener Class**,
Orest Iftime, Amol Sasane
(University of Twente)
For the Wiener class of matrix-valued functions we obtain a simple frequency domain solution for the sub-optimal Hankel norm approximation problem. The approach is via J-spectral factorization.

12:10-12:30 **LQG Balancing in Infinite Dimensions**,
Mark R. Opmeer, Ruth Curtain
(University of Groningen)
Balanced realizations of a linear system are those for which the observability and controllability gramians are both equal and diagonal. Truncated balanced realizations have good approximation properties and are often used for controller design. Of course, balanced realizations only exist for stable transfer functions and it has been proposed that LQG-balanced realizations could prove a useful alternative. LQG-balanced realizations of a system are those for which the solutions of the associated control and filter Riccati equations are equal. While there exists a complete theory of balanced realizations (and truncations) for infinite-dimensional systems, the theory for the LQG versions has yet to be developed. In this paper we solve this problem for discrete-time infinite-dimensional systems.

Room: 129, Session: THA3

Chair: J.M. (Hans) Schumacher
Title: **Systems and Control Theory in Finance and Insurance 1**

10:30-11:30 **Control and Financial Engineering**,
J. M. (Hans) Schumacher (Tilburg University)
The paper provides a review of the basics of financial engineering, with a few examples. We emphasize connections with control theory in a broad sense rather than with stochastic control theory in particular, and the reader is not assumed to be versed in stochastic processes. Two brief case studies are presented: the construction of an indexed bond, and the hedging of long-term contracts for delivery of oil.

11:30-12:00 **Dynamic Risk Sensitive Asset Management With Nonnegative Multiple Factor Constraints**,
Arunabha Bagchi (University of Twente),
K. Suresh Kumar (University of Pennsylvania)
We study the dynamic asset allocation problem with nonnegativity constraints on the economic factors. We first convert the dynamic asset allocation problem into an equivalent stochastic differential game. We then impose nonnegativity constraints on the game problem. We then solve this new problem using some recent results on such constrained differential games. For multifactor constraints, existence of solution of the resulting HJB-equation is analysed in detail.

12:00-12:30 **A Filtered No-arbitrage Model for Term Structures from Noisy Data**,
Andrea Gombani (LADSEB-CNR),
Stefan R. Jaschke (Weierstrass-Institut, Berlin),
Wolfgang J. Runggaldier (University of Padova)
We consider the problem of pricing in financial markets when agents do not have access to full information. The particular problem concerns the pricing of non traded or illiquid bonds on the basis of the observations of the yields of traded zero-coupon bonds. The approach being used gives an example of how stochastic filtering techniques, in particular the Kalman filter, can be usefully applied to pricing under incomplete information.

Room: 136, Session: THA4

Chair: David Nicholls
Title: **Fully Nonlinear, Three-Dimensional, Surface Water Waves in Arbitrary Depth**

10:30-11:00 **Experiments on Deep-Water Waves with Two-Dimensional Surface Patterns**,
Diane Henderson (Penn State)

Experiments are conducted in a three-dimensional wave basin with a wavemaker system comprising 32 side-by-side paddles for which there is precise control. Two types of wavemaker forcings are used to create two-dimensional surface patterns: (1) two symmetric carrier waves interacting at an oblique angle and (2) a single carrier wave propagating in the x-direction with a Jacobi elliptic, sn-function modulation in the y-direction. Data are presented from overhead photographs and from time series obtained by traversing a wave-gage through the patterns. Two parameters are systematically varied: the horizontal aspect ratio of the cells comprising the surface pattern and the measure of nonlinearity of the input wavefield.

11:00-11:30 **Instability of Bounded Solutions of the 2-D Cubic Nonlinear Schrodinger Equation**,
John Carter (Seattle University)
In 1974, Zakharov and Rubenchik established that the soliton solutions of the two-dimensional cubic nonlinear Schrodinger equation (NLSE) are unstable with respect to long-wave transverse perturbations. We establish that all bounded solutions of the NLSE are unstable with respect to long-wave transverse perturbations. All possible sign choices in the NLSE are considered, though we focus on the NLSE as a model of waves on deep water.

11:30-12:00 **Computing (quasi) Periodic Waves in Shallow Water**,
Bernard Deconinck (Colorado State University)
The Kadomtsev-Petviashvili (KP) equation governs the evolution of waves in shallow water. It has a family of (quasi) periodic solutions which are implicitly parametrized by compact, connected Riemann surfaces. This presents a large obstacle for the use of these solutions. I will discuss black box implementations aimed at making the computation of these solutions effective.

12:30-13:00 **Mathematical Models of Deep-Water Waves with two-Dimensional Surface Patterns**,
Harvey Segur, (U. of Colorado)
Another speaker in this session presents intriguing experiments on waves in deep water, with two-dimensional surface patterns that are either periodic or nearly so. These wave patterns persist for relatively long times in the experiments. This talk presents preliminary attempts to find a suitable mathematical model for these observed waves.

Room: 208, Session: THA5

Chair: Krzystof Galkowski, Eric Rogers, Victor Vinnikov
Title: **Multidimensional Systems 5**

10:30-11:00 **Robust Stability and Stabilization of n-D Systems**,
Jiang-Qian Ying (Gifu University, Japan),
Li Xu (Akita Prefectural University, Japan),
Masayuki Kawamata (Tohoku University, Japan)
The stability margin and stabilizability margin of n-D systems are first considered. The stabilizability margin is defined for the first time to be the largest stability margin that a closed-loop feedback system can reach. A general computational algebraic procedure is then proposed for both computation of the stability/ stabilizability margins and construction of a stabilizing compensator which can reach the stabilizability margin as close as desirable.

11:00-11:30 **Succesive stabilization of a class of 2D systems**,
Krzysztof Galkowski, Bartek Sulikowski
(University of Zielona Gora),
Eric Rogers (University of Southampton),
David H. Owens (University of Sheffield)
The subject area of this paper is the application of systems theory developed for linear repetitive processes, a distinct class of 2D linear systems, to linear iterative learning control schemes. A unique feature is the inclusion of experimental results obtained from the application of control laws designed using this theory to an experimental rig in the form of a chain conveyor system.

11:30-12:00 **Optimal Control for a Class of Differential Linear Repetitive Processes**,
Eric Rogers (University of Southampton),
S. Dymkou (Ballarat University, Australia),
M. Dymkov (National Academy of Sciences of Belarus, Minsk),
K. Galkowski (University of Zielona Gora),
D. H Owens (University of Sheffield)
Differential repetitive processes are a class of continuous-discrete 2D linear systems of both systems theoretic and applications interest. The feature which makes them distinct from other classes of such systems is the fact that information propagation in one of the two independent directions only occurs over a finite interval. In this paper, we develop new results on optimal and sub-optimal control of an important sub-class of these processes.

12:00-12:30 **Relation between Eigenvalues and Singular Values in the Problem of Stability Maintenance of Ellipsoidal Estimates**,
Taalaibek A. Akunov, Anatoly V. Ushakov (Technical University, St. Petersburg, Russia)
Problem of defining of relation between eigenvalues and singular values of matrix and matrix-valued functions of the matrix is considered. The problem arises at the interfaces between methods of systems synthesis with use of generalized modal control and quality evaluation of these systems with the help of ellipsoidal quality estimates. Solution is oriented on maintenance of stability of ellipsoidal quality estimates by means of stabilisation of state matrix eigenvalues and eigenvectors.

Room: 209, Session: THA6

Chair: Koichi Hashimoto
Title: **Globally Stable Robust Visual Servoing**

10:30-11:00 **Keeping Features in the Camera's Field of View: a Visual Servoing Strategy**,
K. Hashimoto (University of Tokyo), Graziano Chesi, D. Prattichizzo, A. Vicino (University of Siena)
A new visual servoing strategy ensuring global convergence and all points in the field of view without requiring any knowledge on the 3D model of the scene is proposed. Moreover, the camera trajectory length is minimized in the rotational space and, for some cases, also minimized in the translational space. Robustness against uncertainties on the camera intrinsic parameters and optical axis direction is also guaranteed.

11:00-11:30 **Binocular Visual Servoing with a Limited Field of View**,
Noah Cowan (University of California at Berkeley)
This paper presents a simple, globally convergent, binocular image-based visual servoing algorithm which accounts for the limited field-of-view of a CCD camera system. Recourse to Navigation Functions, a refined notion of artificial potential functions, leads to controllers for first order, quasi-static as well as second order, dynamic plants. Underlying these constructions is a global account of the transformation between the task and image space.

11:30-12:00 **Visual Servoing with Dynamics: Control of an Unmanned Blimp**,
Jim Ostrowski (University of Pennsylvania)
No Abstract

12:00-12:30 **Enlarging the Stable Region of Image Based Control by Path Planning**,
Youcef Mezouar (Columbia University)
No Abstract

Room: 210, Session: THA7

Chair: Bill Helton, Andre Ran, Leiba Rodman
Title: **Matrix and Operator Equations II**

10:30-11:00 **Noncommutative Convexity of Functions and Sets**,
J. William Helton (University of California, San Diego)
The type of convexity one sees in many linear systems applications is "matrix convexity". Namely, one has a noncommutative rational function and requires it be "convex" when matrices are plugged in. The talk concerns work with Scott McCullough characterizing such functions and also characterizing those "noncommutative regions" which can be represented with Linear functions (LMI). The tools include a new noncommutative Positivestellensatz.

11:00-11:30 **Symmetry Groups, Semidefinite Programming,and Sums of Squares**,
Pablo A. Parrilo (ETH)
No Abstract

11:30-12:00 **The Symmetric Linear Matrix Equation**,
Martine C. B. Reurings (Vrije Universiteit, Amsterdam)
In this talk the matrix equation $X + A_1^* X A_1 + \cdots + A_m^* X A_m = Q$ is considered, where Q is positive definite and the $A_j, j = 1, \ldots, m$ are arbitrary matrices. For $m = 1$ the equation becomes $X + A_1^* X A_1 = Q$. Note the difference with the Stein equation. It is known that the equation for $m = 1$ has a unique positive definite solution if $A_1^* Q A_1 < Q$. In the general case a similar condition is sufficient for the existence of a unique positive definite solution, but we cannot use the same techniques as were used in the case $m = 1$. Our proof depends on the notion of the Kronecker product of two matrices.

12:00-12:30 **Investigating Duality on Stability Conditions**,
Mauricio de Oliveira (UNICAMP)
This paper is devoted to investigate the role played by duality in stability analysis of linear time-invariant systems. We seek for a dual statement of a recently developed method for generating stability conditions, which combines Lyapunov stability theory

with Finsler's Lemma. This method, developed in the time domain, is able to generate a set of (primal) equivalent stability tests involving extra multipliers. The resulting tests have very attractive properties. Stability is characterized via Linear Matrix Inequalities and we use optimization theory to obtain the duals. The dual problems are given a frequency domain interpretation.

Middle:

Room: 102, Session: THM1

Chair: Mark Alber

Title: **Complex Networks and Biological Applications 2**

14:00-14:40 **Synchronization of Oscillators in Small World Systems**,

Lou Pecora (Naval Research Laboratory)

Smallworld networks are regular lattices of connected nodes to which random connections have been added. Recently, Watts and Strogatz showed that only a few random, long-range connections are necessary to create paths that are very short even between diametrically opposed nodes. An interesting question regarding smallworld systems is, how do such added, random connections affect dynamics on the lattice if the nodes are oscillators? In particular, is the intuitive view that additional connections, even random ones, would help stabilize a synchronous state correct? We show that we can use the recently formulated master stability approach to synchronization stability to probe synchronization in smallworld systems in a direct and generic way. The results are often not what one expects. In some cases added connections can both help and hurt synchronization. The opposite case of the saturated world is equally interesting and argues for a symmetry-breaking approach to study ef! fects at both ends of the connection distribution. We also compare the results for smallworld, random networks to highly regular networks/graphs. The smallworld networks do as well as the best regular networks.

14:40-15:20 **Intracellular Signaling is Dependent on the Cytoskeleton.**,

Gabor Forgas (University of Missouri Columbia)

No Abstract

15:20-16:00 **The Role of Scale-free Connectivity Patterns in Spreading Phenomena**,

Alessandro Vespignani (ICTP)

We show that the large connectivity fluctuations usually found in scale-free networks strengthen considerably the incidence of epidemic outbreaks. Scale-free networks, which are characterized by diverging connectivity fluctuations, exhibit the lack of an epidemic threshold and always show a finite fraction of infected individuals. This particular weakness is found also in immunization strategies that can be successfully developed only by taking into account the connectivity patterns of scale-free networks. The understanding of epidemics in scale-free networks might deliver new insights in the spread of information and diseases in biological and technological networks that often appear to be characterized by complex heterogeneous architectures.

Room: 126, Session: THM2

Chair: Ruth Curtain, Olof Staffans

Title: **Distributed Parameter Systems: Theory Part II**

14:00-14:30 **Zeros of SISO Infinite-Dimensional Systems**,

Kirsten Morris (University of Waterloo),
Richard Rebarber (University of Nebraska)

We define the zeros of SISO infinite-dimensional systems with bounded control and observation operators B and C respectively in terms of the spectrum of an operator on an invariant subspace. If the range(B) is not in ker(C), we calculate the operator K such that the spectrum of A+BK on ker(C) is the system zeros. Also, A+BK generates a semigroup on ker(C). If the range(B) is in ker(C), a number of situations may occur, depending on the nature of B and C.

14:30-15:00 **Stabilizability of Systems with Signals in $\ell_2(\mathbb{Z})$**,

Birgit Jacob (University of Dortmund)

We consider a system as a (possibly unbounded) linear operator from $\ell_2(\mathbb{Z})$ to $\ell_2(\mathbb{Z})$. In this setup even a simple causal convolution system is not stabilizable is the usual sense of the term. We discuss this problem, and we "solve" the problem by adapting the definition of stabilizability. Finally, we compare the obtained controller with the one we obtain by restricting our system to $\ell_2(\mathbb{N}_0)$.

15:00-15:30 **Stability and Boundedness of Continuous and Discrete-Time Systems**,

Hans Zwart, B.Z. Guo
(University of Twente)

We investigate the relation between discrete and continuous systems on a Hilbert space. More precisely, we investigate the stability properties of the semigroup generated by the operator A, and the sequence A_d^n, where n is a positive integer, and A and A_d are related via $A_d = (I + A)(I - A)^{-}1$, or equivalently

$A = (A_d - I)(A_d + I)^-1$. One of our result states that if A and its inverse generate a bounded semigroup, then A_d^n is uniformly bounded.

15:30-16:00 **Coprimeness Conditions for Pseudorational Transfer Functions**,
Yutaka Yamamoto (Kyoto University)
This paper surveys and discusses some coprimeness issues for the class of pseudorational transfer functions. They are effective in capturing various system properties for systems with bounded-time memory, e.g., delay systems. Various notions of coprimeness are known to be non-equivalent. We show, however, that under some conditions spectral coprimeness implies exact coprimeness (existence of Bezout identity).

Room: 129, Session: THM3

Chair: J.M. (Hans) Schumacher
Title: **Systems and Control Theory in Finance and Insurance 2**

14:00-15:00 **Ruin Probabilities Minimization and Dividend Distribution Optimization in Diffusion Models**,
Michael Taksar
This will serve as an introduction to the stochastic control models in insurance. We will consider a model of an insurance company which has different modes of risk and financial control. Different types of reinsurance correspond are the risk reduction techniques of the insurance, while financial control is a more familiar portfolio rebalancing. There are different objectives which the company pursues. One is the classical minimization of ruin probabilities. Another one is dividend pay-out maximization. The latter merges with the classical finance issue of a small investor pioneered by Merton. Diffusion approximation enables one to get a closed form solution to many problems and see early the structure of the optimal policy.

15:00-15:30 **Continuous-Time Mean-Variance Portfolio Selection with Markov-Modulated Market Parameters**,
Xun Yu Zhou (Chinese University Hong Kong
No Abstract

15:30-16:00 **Stock Selection Based on Cluster and Outlier Analysis**,
Steven Craighead, Bruce Klemesrud
(Nationwide Financial, Columbus, Ohio)
In this paper, we study the selection and active trading of stocks by the use of a clustering algorithm and time series outlier analysis. The Partitioning Among Mediods (PAM) clustering algorithm of Kaufman and Rousseeuw(1990) is used to restrict the initial set of stocks. We find that PAM is effective in its ability to specify nonuniform stock series from the entire universe. We are pleasantly surprised that the algorithm eliminated the bankrupt Enron and Federal Mogul stock series, without our intervention. We use outlier analysis to define two separate active trading strategies. The outliers within a time series are determined by the use of a Kalman Filter/Smoother model developed by de Jong and Penzer(1998). Weekly trading in stocks with an initial $30,000 with a closed stock portfolio from 1993 to 2001, we obtained a 17.8% annual return on a cash surrogate passive strategy, 18.1% on a passive strategy using all the stocks in our restricted asset universe, 20.2% on a combined cash protected and outlier active strategy, and 23.3% using the outlier active strategy only. Comparing these results to the passive strategy being entirely invested in the S&P 500 Large Cap index with at 9.9% return, we find that under this stock portfolio any of our strategies are superior to that of a purely passive index strategy.

Room: 136, Session: THM4

Chair: Paul Van Dooren
Title: **Robust Control and Linear Matrix Inequalities**

14:00-14:30 **Linear Matrix Inequalities in Robust Control: A Brief Survey**,
Venkataramanan Balakrishnan (Purdue University)
Control system models must often explicitly incorporate in them uncertainties or perturbations. Robust control deals with the analysis of and design for such uncertain control system models. This paper provides a brief survey to some robust control techniques that are based on numerical convex optimization over Linear Matrix Inequalities (LMIs).

14:30-15:00 **Periodic Multirate Systems, nu-Gap and Robust Stabilization**,
Li Qiu, Li Chai
(Hong Kong University of Science & Technology)
A new discription of multirate systems, called multirate periodic system, is given using the concept of periodic time-varying input-output spaces. We then define the ν-gap metric of two multirate periodic systems and study the robust stabilization with this metric. The optimal robust stabilization margin is explicitly computed and an obsever-form suboptimal controller is given. The solution amounts to solving two discrete-time algebraic Riccati equations and an extended Parrot problem.

15:00-15:30 **Spectral Factorization and Sums of Squares via Semidefinite Programming**,
Hugo Woerdeman (College of William and Mary)
It is known that a matrix (trigonometric) polynomial that is nonnegative definite on the real axis (on the unit circle) allows an outer factorization. In this paper we investigate the different possibilities how the outer factor may be determined via semidefinite programming. In the dual formulation this leads to a question what possible barrier functions there exist for classes of positive semidefinite structured block matrices. The multivariable version, i.e., finding sums of squares representations, is also explored. Appropriate definitions for outer in this context also come to pass.

15:30-16:00 **Robustness Analysis via Stability Radii, Spectral Value Sets and mu-Functions**,
Michael Karow (Technical University of Berlin)
This is an introductory talk on robustness problems concerning the stability of uncertain finite dimensional linear systems. Our tools are stability radii, spectral value sets (pseudospectra) and μ-function for structured matrix perturbations. We discuss the relationship between these quantities and give explicit formulas for several perturbation structures. In particular, we regard real perturbations and pseudospectra of composite systems.

Room: 208, Session: THM5

Chair: Maria Elena Valcher
Title: **The Behavioral Approach to Dynamic Systems**

14:00-14:30 **Deterministic Kalman Filtering**,
Jan C. Willems (University of Leuven, Belgium)
A deterministic interpretation of the Kalman filtering formulas is given, using the principle of least squares estimation. The observed signal and the to-be-estimated signal are modeled as being generated as outputs of a finite-dimensional linear system driven by an input disturbance. Postulating that the observed signal is generated by the input disturbance that has minimal least squares norm leads to a method of computing an estimate of the to-be-estimated output.

14:30-15:00 **Over-Determined Systems**,
Eva Zerz (University of Kaiserslautern)
Over-determined systems are a special type of autonomous systems. They are algebraically characterized by kernel representation matrices that are minor right prime. The systems theoretic significance of the notion is closely related to the extension problem, an over-determined boundary value problem in which the values of the desired function are prescribed in a whole neighborhood of the boundary.

15:00-15:30 **Regular Implementability nD Behaviors**,
Paula Rocha (University of Aveiro, Portugal)
We consider the problem of implementability and regular implementability of a nD behavior by interconnection through a control variable. In the 1D case, the second property is equivalent to the regular implementability of the desired system variable behavior by full interconnection. A similar result is not valid in the nD case. However we obtain an alternative characterization in terms of the regular implementability of a suitable control variable behavior.

15:30-16:00 **Cones of Trajectories as Subsets of Linear Systems: the Autonomous Case**,
Andrea Morettin (Università di Padova)
In most pratical applications the designer has to face physical and technological constraints that lead to a set of inequalities involving the variables of the model. In order to provide a formal framework for dealing with this situation, we introduce the concept of conical behaviour as a time-invariant cone of real trajectories which is complete. We describe such a set in relation with the minimal vector space that contains it. In particular, we afford this problem by assuming that the conical behaviour is autonomous, i.e. a trajectory note in finite time window is totally defined. If a conical behaviour is polyhedral it admits a nonnegative state representation. In a dual look a conical behaviour may be the set of trajectories which satisfies a model of a finite number of inequality constraints that act on a finite time window of the trajectory itself.

Room: 209, Session: THM6

Chair: Naomi Leonard
Title: **Control and Dynamics of Mechanical Systems I**

14:00-14:20 **Composition of Dirac Structures and Control of Port-Hamiltonian Systems**,
Arjan van der Schaft (University of Twente),
J. Cervera (Universidad de Murcia, Spain)
Key feature of Dirac structures (as opposed to Poisson or symplectic structures) is the fact that the composition of Dirac structures again defines a Dirac structure. This implies that any power-conserving interconnection of port-Hamiltonian systems is a port-Hamiltonian system itself. Furthermore, the composed Dirac structure determines the closed-loop algebraic constraints, as well as its Casimir functions. In this paper the set of achievable composed Dirac

structures for a given plant port-Hamiltonian system is characterized.

14:20-14:40 **Hamiltonian Attitude Dynamics for a Spacecraft with a Point Mass Oscillator**,
Craig Woolsey (Virginia Tech)
Two noncanonical Hamiltonian models are presented for the dynamics of a rigid body with an constrained moving point mass. One of these models is used to analyze stability of steady principal axis rotation of a rigid body with a spring-mass oscillator. The analysis gives necessary and sufficient conditions for stability of steady major axis rotation, as well as sufficient conditions for instability of intermediate and minor axis rotation.

14:40-15:00 **Controllable Kinematic Reductions for Mechanical Systems: Concepts, Computational Tools, and Examples**,
Andrew Lewis (Queen's University),
Francesco Bullo (University of Illinois at Urbana-Champaign),
Kevin M. Lynch (Northwestern University)
This paper introduces the novel notion of kinematic reductions for mechanical systems and studies their controllability properties. We focus on the class of simple mechanical control systems with constraints and model them as affine connection control systems. We present a comprehensive treatment of local controllability properties of mechanical systems and their kinematic reductions.

15:00-15:20 **Matching and Stabilization of Linear Mechanical Systems**,
Dimitri Zenkov (North Carolina State University)
We consider linear controlled mechanical systems and show that controllability enables one to use the method of controlled Lagrangians for feedback stabilization of equilibria.

15:20-15:40 **Matching and Stabilization of Constrained Systems**,
Guido Blankenstein (EPFL)
In this paper we discuss the stabilization by means of structure preserving feedback laws (i.e., matching) of constrained systems described as implicit port-controlled Hamiltonian systems. The theory is applied to underactuated mechanical systems with kinematic constraints.

15:40-16:00 **Extremal Flows on Stiefel Manifolds, and Riemannian Potatoes**,
Peter Crouch (ASU),
Anthony M. Bloch (University of Michigan)
In this paper, we consider an optimal control problem, or constrained variational problem, that evolves on a general Stiefel Manifold, posed in both continuous and discrete time. At one extreme this problem yields a symmetric realization of the generalized rigid body system, and at the other extreme reduces to the geodesic flow on an ellipsoid. We work out the Hamiltonian structure of the general extremal flow using the optimal control formalism revealing its complexity.

Room: 210, Session: THM7

Chair: Jan van Schuppen
Title: **Control and Algebra**

14:00-14:30 **Control and Algebra - An Introduction**,
Jan H. van Schuppen (CWI, Amsterdam)
The concept of bisimulation has been developed in computer science by R. Milner for the study of equivalences of transition systems. It has been generalized to coalgebra and to category theory. In control and system theory the concept of bisimulation is useful for the study of relations of dynamic systems, in particular of observationally equivalent systems. This short paper is an introduction to the session 'Control and Algebra'.

14:30-15:00 **Towards an Algebraic Systems Theory of Hybrid Systems**,
George J. Pappas (University of Pennsylvania)
The fundamental notion of bisimulation has inspired various notions of system equivalences in concurrency theory. Many notions of bisimulation for various discrete systems have been recently unified in the abstract category theoretical formulation of bisimulation due to Joyal, Nielsen and Winskel. In this paper, we adopt their framework and unify the notions of bisimulation equivalences for discrete, continuous dynamical and control systems. This shows that our equivalence notion is on the right track, but also confirms that abstract bisimulation is general enough to capture equivalence notions in the domain of continuous systems. We believe that the unification of the bisimulation relation for labelled transition systems and dynamical systems under the umbrella of abstract bisimulation, as achieved in this work, is a first step towards a unified approach to modeling of and reasoning about the dynamics of discrete and continuous structures in computer science and control theory.

15:00-15:30 **The Category of a Affine Connection Control Systems**,
Andrew Lewis (Queen's University)
The category of affine connection control systems is one whose objects are control affine systems whose drift vector field is the geodesic spray of an affine connection, and whose control vector fields are vertical lifts to the tangent bundle of vector fields on configuration space. This class of system includes a large and important collection of mechanical systems. The morphisms (feedback transformations) in this category are investigated.

15:30-16:00 **Coalgebra and Supervisory Control with Partial Observations**,
Jan Komenda (CWI, Amsterdam)
Coalgebraic techniques are applied to the supervisory control of discrete-event systems with partial observations. Classical notions from concurrency theory are specialized to control theory.The concept of weak transitions enables the relational characterization of observability and gives rise to a coalgebraic formulation of the necessary and sufficient conditions for the existence of a supervisory control which achieves a considered legal language.

Afternoon:

Room: 102, Session: THP1
Chair: Mark Alber
Title: **Complex Networks and Biological Applications 3**

16:30-17:00 **Connections Matter: A Boolean Model for the Segment Polarity Network of Drosophila Melanogaster**,
Reka Albert (University of Minnesota)
The Drosophila segment polarity genes form a complex network of cross-regulatory interactions. Through the functioning of this network the initial expression of the segment polarity genes is stabilized and maintained throughout several stages of embryonic development including two rounds of cell divisions. In this talk I propose a Boolean representation of this network that assumes that genes and proteins are either ON or OFF, and their interactions can be formulated as logical functions. This model is deeply rooted in the topology of the segment polarity network, while it disregards the biochemical details of the interactions. The model is able to reproduce the wild type expression pattern of the segment polarity genes, as well as the ectopic expressions obtained for gene mutation experiments. In addition, the Boolean representation allows for a more complete analysis of the possible steady states as experiments, and for a better identification of the initial conditions that lead to certain steady states. I propose this type of analysis as a first, qualitative step in understanding complex networks. The success of a Boolean representation of a network strongly suggests that the topology of the network is correctly taken into account, and a more quantitative approach can be used.

17:00-17:30 **Modeling Mesenchymal Condensation during Limb Chondrogenesis**,
Gilberto Tomas (University of Notre Dame)
We study a quasi-2D micromass cell culture of chick limb-bud cells which undergoes chondrogenesis that qualitatively resembles chondrogenesis in vivo. Disassociated mesenchymal cells, after plating at high density, form local condensations, which then differentiate into cartilage. A similar process in the intact embryonic limb leads to the formation of skeletal primordia. Among several possible underlying mechanisms of mesenchymal condensation, we concentrate on local cell-cell adhesion and cell-extracellular matrix interaction and propose a stochastic pattern formation mechanism for cell clustering. We implement a 2D extended Potts Model simulation and we discuss how this mechanism could be an important part of mesenchymal condensation in limb chondrogenesis in vitro and in vivo.

17:30-18:00 **Classification of scale-free networks**,
Byungnam Kahng (Seoul National University)
While the emergence of a power law degree distribution in complex networks is intriguing, the degree exponent is not universal. Here we show that the betweenness centrality displays a power law distribution with an exponent η which is robust and use it to classify the scale-free networks. We have observed two universality classes with $\eta \approx 2.2$ and 2.0, respectively. Real world networks for the former are the protein interaction networks, the metabolic networks for eukaryotes and bacteria, and the co-authorship network, and those for the latter one are the Internet, the world-wide web, and the metabolic networks for archaea. Distinct features of the mass-distance relation, generic topology of geodesics and resilience under attack of the two classes are identified. Various model networks also belong to either of the two.

18:00-18:30 **Prediction of Protein Essentiality Based on Genomic Data**,
Hawoong Jeoong (Korea Advanced Inst. of Science and Technology Taejon),
Zoltan N. Oltvai (Northwestern University Medical School)
Albert-Laszlo Barabasi (University of Notre Dame)

A major goal of pharmaceutical bioinformatics is to develop computational tools for systematic in silico molecular target identification. Here we demonstrate that in the yeast, Sacharomyces cerevisiae, the phenotypic effect of single gene deletions simultaneously correlate with fluctuations in mRNA expression profiles, the functional categorization of the gene products, and their connectivity in the yeast's protein-protein interaction network. Building on these quantitative correlations we developed a computational method for predicting the phenotypic effect of a given genes functional disabling or removal. Our subsequent analyses were in good agreement with the results of systematic gene deletion experiments, allowing us to predict the deletion phenotype of a number of untested yeast genes. The results underscore the utility of large genomic databases for in silico systematic drug target identification in the postgenomic era.

Room: 126, Session: THP2

Chair: Kirsten Morris, Olof Staffans
Title: **Distributed Parameter Systems: Stabilization and Control, Part I**

16:30-17:00 **Reciprocals of Regular Linear Systems: a Survey.**,
Ruth Curtain (University of Groningen)
This paper proposes a novel approach to studying regular linear systems via their reciprocal systems. Under the generic assumption that A has a bounded inverse, a regular linear system possesses a reciprocal system with four bounded generating operators. Many system theoretic problems for regular linear systems can be translated into equivalent problems for their reciprocal system. Due to the bounded nature of the generators, the problems for the reciprocal system are easier to solve and these solutions can be translated back to solutions for the original regular linear system. Properties of reciprocal systems are reviewed and the success of this approach is illustrated with the LQ control problem and the existence of (pseudo-) coprime factorizations. Another very successful application of reciprocal systems is to obtain explicit formulas for solutions to spectral factorization problems in terms of the original unbounded operators A,B,C,D (see Curtain and Sasane, this conference). The reciprocal approach has also great potential for other problems for regular linear systems, for example, H-infinity control, sampling and the robust stability radius. Finally, we remark that similar conclusions hold if we replace the assumption that A has a bounded inverse by the assumption that for some real number a, aI-A does.

17:00-17:30 **H-infinity Control of Acoustic Noise in a Duct with a Feedforward Configuration**,
Kirsten Morris (University of Waterloo)
A mathematical model of sound propagation in a duct derived from physical principles is described. Experimental results validate the model. Theoretical limits of noise reduction are examined using this model. In many feedforward configurations, the optimal controller can reduce the noise at a point to almost zero. However, no noise reduction is obtained at points below the performance point, and at many such points the noise level is increased.

17:30-18:00 **Positivity and Dissipativity of Oscillating Diffusive Filters, Application to the Stability of Coupled Systems**,
G. Dauphin, Denis Matignon
(ENST/TSI & CNRS, URA 820)
Oscillating diffusive filters such as Gegenbauer filters have a slowly decreasing impulse response. They are a continuous aggregation of positive oscillating filters; hence, they are positive and have a dissipative realization, which helps prove both the external and internal stabilities of some coupled systems involving a rational filter and such an oscillating diffusive filter in the feedback loop.

18:00-18:30 **Can Positive Pseudo-Differential Operators of Diffusive Type Help Stabilize Unstable Systems?**,
Denis Matignon (ENST/TSI & CNRS, URA 820)
Diffusive representations of positive pseudo-differential operators can often be used in the analysis of coupled systems, in which their dissipative realization plays a major role. Now, some coupled systems involving a negative PDO can still be stable. Conversely, some unstable systems can be stabilized by positive PDOs, thus requiring some more analytical knowledge: such striking examples will be presented, either in continuous time or in discrete time.

Room: 129, Session: THP3

Chair: Tyrone Duncan
Title: **Stochastic Theory and Applications**

16:30-17:00 **An Approach to Stochastic Integration for Fractional Brownian Motion in a Hilbert Space**,
Tyrone Duncan, B. Pasik-Duncan,
(University of Kansas)
J. Jakubowski (University of Warsaw)
A Hilbert-valued stochastic integration is defined for an integrator that is a cylindrical fractional Brownian motion in a Hilbert space. Since the integrator is

not a semimartingale for the fractional Brownian motions considered, a different definition of integration is required. Both deterministic and stochastic operator-valued integrands are used. The approach to integration has an analogue with Skorokhod integrals for Brownian motion by the basic use of a derivative of some functionals of Brownian motion. An Ito formula is given for some processes obtained by this stochastic integration.

7:00-17:30 **A Class of Tractable Partially Observed Discrete Stochastic Games**,
William McEneaney
(University of California at San Diego)
Stochastic games under partial information are typically computationally intractable even in the discrete-time/discrete-state case. We consider a problem where one player has perfect information. A chief difficulty is that the information state for the other player is infinite-dimensional. However, in the problem type here, the information state and state-feedback value functions are finite-dimensional. Thus computational tractability is greatly enhanced.

17:30-18:00 **Hybrid Stock Models and Parameter Estimation**,
George Yin (Wayne State University),
Q. Zhang (University of Georgia),
K. Yin (University of Minnesota)
In this work, we study a class of hybrid models for the stock market to account for the coexistence of continuous dynamics and discrete events. Different from the original geometric Brownian motion models, both the rate of return and the volatility in the hybrid model depend on a continuous-time Markov chain. This model can deal with random volatility by incorporating market trend with other economic factors. To use the models requires being able to estimate the values of elements of the generator of the underlying Markov chain. We develop a stochastic approximation-based algorithm for the estimation task. The asymptotic properties including convergence and rates of convergence of the algorithm are proved. Using the estimated generator, one can then proceed to make equity liquidation decisions.

18:00-18:30 **Jump-Diffusion Stock Return Models in Finance: Stochastic Process Density with Uniform-Jump Amplitude**,
Floyd B. Hanson (University of Illinois at Chicago),
J. J. Westman (UCLA)
The stochastic analysis is presented for the parameter estimation problem for a weighted least squares fitting a theoretical jump-diffusion model to the log-returns from closing data of the Standard and Poor's 500 (S&P500) stock index during the prior decade 1992-2001. The jump-diffusion model combines the usual log-normal diffusion and a log-uniform jump distribution. The results are applied to an optimal portfolio application in a computational companion paper.

Room: 136, Session: THP4
Chair: Georg Heinig, Vadim Olshevski
Title: **Computational Methods for Structured Matrices and Applications**

16:30-17:00 **Split Algorithms for Toeplitz and Toeplitz-plus-Hankel Matrices**,
Georg Heinig (Kuwait University)
New algorithms for Toeplitz and Toeplitz-plus-Hankel matrices are presented that are in the spirit of the split algorithms of Delsarte/Genin. It is shown that the split algorithms are related to ZW-factorizations like the classical algorithms are related to LU-factorizations. Special attention is paid to skewsymmetric Toeplitz, centrosymmetric, and general T+H matrices.

17:00-17:30 **Structured LDPC Codes**,
Amin Shokrollahi (EPFL)
No Abstract

17:30-18:00 **Efficient Matrix Computations in Wideband Communications**,
Patrick Dewilde (Delft University of Technology),
Lang Tong (Cornell University)
Alle-Jan van der Veen
(Delft University of Technology)
Modern telecommunications put increasing demands on the efficient use of bandwidth in a channel. An important general technique used in wideband communications is code division multiple access, and for large bandwidths, it uses a long, time-varying code to achieve the spreading. Optimal and optimally efficient signal recovery can be achieved using modern methods of time-varying system theory. A nice example of system theory applied to modern communications.

18:00-18:30 **Stable Factorization of Hankel and Hankel-like Matrices**,
Vadim Olshevsky (Georgia State University),
Michael Stewart
This talk will outline stable Schur-type algorithms for the factorization of Hankel and Hankel-like matrices. The algorithm factors the matrix by applying symplectic transformations, instead of hyperbolic transformations, to generators. The new algorithms can be

proven to be backward stable with a particular choice of symplectic transformations.

Room: 209, Session: THP5
Chair: Naomi Leonard
Title: **Control and Dynamics of Mechanical Systems II**

16:30-16:50 **On the Ball and Beam Problem: Regulation with Guaranteed Transient Performance and Tracking Periodic Orbits**,
Romeo Ortega (LSS-Supelec)
Fabio Gomez-Estern, Javier Aracil,
Francisco Gordillo
(Escuelo Superior de Ingenieros)
Despite the large number of controllers presented in the literature for the stabilization of the ball and beam system, only a few results are available on the transient performance problem. The aim of this paper is to propose an asymptotically stabilizing controller that ensures that, for a well defined set of initial conditions, the ball remains on the bar during the transient. Tuning the controller, the set can be extended to include any initial position with zero velocity. The controller is a nonlinear static state feedback that is derived using the interconnection and damping assigment energy-shaping controller design methodology. As an extension of the regulation problem we also propose in this paper a controller that forces the ball and beam to oscillate. This is achieved, within the framework of energy-shaping, by assigning an energy function that attains its mimimum along the desired periodic orbit. A key step in our design is the immersion of the oscilator system into the fourth order system dynamics.

16:50-17:10 **Reduction of Controlled Lagrangian Systems with Symmetries**,
Dong Eui Chang (Cal Tech)
We extend the theory of controlled Lagrangian systems to include systems with symmetry and the Lagrangian reduction theory. This extension is crucial to study examples such as spacecraft control, underwater vehicle control, etc.

17:10-17:30 **Constrained Mechanical Systems with Impacts**,
Patrick Hagerty (University of Arizona)
No Abstract

17:30-17:50 **Adjoints of Hamiltonian Systems and Iterative Learning Control**,
Kenji Fujimoto, Toshiharu Sugie
(Kyoto University)
This paper is concerned with a study on the variational systems and their adjoints of Hamiltonian control systems and its application to iterative learning control, which is applicable to electro-mechanical systems. The proposed learning method does not require either the knowledge of physical parameters of the target system nor the time derivatives of the output signals.

17:50-18:10 **Controllability of Mechanical Systems with Constraints and Symmetry**,
Jorge Cortes (University of Twente),
Sonia Martínez
(Consejo Superior de Investigaciones Centifícas),
Jim P. Ostrowski (University ov Pennsylvania),
Hong Zhang (Rowan University)
We develop tools within the affine connection formalism for the control of underactuated mechanical systems evolving on a principal fiber bundle. We present reduced formulations of the Levi-Civita and the nonholonomic affine connections in the presence of symmetries and nonholonomic constraints. Specialized controllability tests are developed, and the notion of fiber configuration controllability is introduced. The results are illustrated in a planar blimp.

18:10-18:30 **The Use of Information in Swarm Motions of Autonomous Vehicles**,
John Baillieul (Boston University)
We discuss recent work on the distributed coordinated control of a system (swarm) of mobile robots whose members possess distinct for sensing their position and environment. Analysis is carried out in which it is assumed that some of the robots have global position knowledge (within some work domain) while other robots are only able to locate themselves only in a local sense with respect to obstacles and other robots. Formation motions and leader-follower strategies are called for, and it is shown that care must be taken to keep the followers from colliding with obstacles and each other.

Room: 210, Session: THP6
Chair: Jan Willem Polderman
Title: **New Approaches to Adaptive Control**

16:30-16:50 **Cautious Hierarchical Switching Control of Stochastic Linear Systems**,
Marco Campi (University of Brescia),
Jaoa Hespanha
(University of California, Santa Barbara),
M. Prandini (University of Brescia)

In this paper, we propose a supervisory switching logic that takes into account the uncertainty on the estimated process model when performing controller selection. If the candidate controller set is hierarchically structured, the supervisor automatically selects the controller that appropriately compromises robustness and performance, given the actual level of uncertainty on the process description. Randomized algorithms make the approach feasible.

16:50-17:10 **Strong Robustness in Multi-Phase Adaptive Control: the Basic Scheme**,
Maria Cadic, Jan Willem Polderman
(University of Twente)
The general structure of adaptive control systems based on strong robustness is introduced. This adaptive approach splits into two phases. The first phase focuses on identification until enough information is obtained to design a controller stabilizing the actual system. This is achieved if the input sequence is such that the uncertainty on the system parameters to be controlled decreases sufficiently fast. Then, in the second phase, emphasis is shifted to control.

17:10-17:30 **Near Optimal LQR Performance for Uncertain First Order Systems**,
Daniel Miller (University of Waterloo),
Li Luo (IBM Canada Toronto Laboratory)
In adaptive control, the objective is to provide stability and acceptable performance in the face of significant plant uncertainty. However, often there are large transients in the plant output and the control signal can become excessively large. Here we consider the first order case with the plant parameters restricted to a compact set; we show how to design a (linear time-varying) adaptive controller which provides near optimal LQR performance.

17:30-17:50 **Self-Tuning Control for Polynomial Systems: an Algorithmic Perspective**,
Iven Mareels (University of Melbourne)
A two stage adaptive or self-tuning control algorithm applicable to systems described by transition maps that are polynomial in state, input and parameter variables is discussed. The feedback is defined only on the basis of past input and output measurements. In a first finite time stage the system to be controlled is identified together with its state trajectory. In a second stage a local observer, is used in conjunction with a receding horizon control scheme to effectuate the control objective. We discuss briefly the computational complexity aspects of this approach to adaptive or self-tuning control.

17:50-18:10 **Geometry of Adaptive Control, Part II: Optimization and Geodesics**,
Felipe Pait, Diego Colon
(University of Sao Paulo)
Two incompatible topologies appear in the study of adaptive systems: the graph topology in control design, and the coefficient topology in system identification. Their incompatibility is manifest in the stabilization problem of adaptive control. We argue that this problem can be approached by changing the geometry of the sets of control systems under consideration: estimating n_p parameters in an n_p-dimensional manifold whose points all correspond to stabilizable systems. One way to accomplish this is using the properties of the algebraic Riccati equation. Parameter estimation in such a manifold can be approached as an optimal control problem akin to the deterministic Kalman filter, leading to algorithms that can be used in conjunction with standard observers and controllers to construct stable adaptive systems.

18:10-18:30 **Two Scale High Gain Adaptive Control**,
Jan Willem Polderman (University of Twente),
Iven Mareels (University of Melbourne)
Simple adaptive controllers based on high gain output feedback suffer a lack of robustness with respect to bounded disturbances. Existing modifications achieve boundedness of all solutions but introduce solutions that, even in the absence disturbances, do not achieve regulation. In this paper a new modification that achieves the desired robustness without the side-effect of undesirable solutions is proposed.

Friday **August 16, 2002**

8:00-9:00 ***Room*****: 101 Plenary Talk**

Anthony Bloch (University of Michigan),
Conservative and Dissipative Dynamics in Classical and Quantum Systems.
In this talk I will discuss dissipative behavior in mechanical systems which preserve energy. The talk will encompass both the classical and quantum domains. In the classical context I will consider Hamiltonian systems and almost Poisson systems such as nonholonomic systems. I will also discuss both classical and quantum systems of oscillators interacting with fields and the phenomena of decoherence and dissipation in this setting.

9:00-10:00 *Room*: 101 Invited Talk

Raffaello D'Andrea (Cornell University),
A State Space Approach to Control of Spatially Interconnected Systems
In this talk a state space approach to controlling systems with a highly structured interconnection topology is presented. It is shown that by capturing these systems as fractional transformations on temporal and spatial operators, many standard results in control – such as the bounded real lemma, H-infinity optimization, and robustness analysis – can be generalized accordingly. The state space formulation yields conditions that can be expressed as linear matrix inequalities. Applications of this control design methodology to several hardware test-beds, including formation flight of autonomous vehicles, is also discussed.

9:00-10:00 *Room*: 102 Invited Talk

Allen Tannenbaum (Georgia Institute of Technology),
Controlled Active Vision in Image Guided Surgery and Therapy.
We will describe use biomedical engineering methods that can be integrated into complete therapy delivery systems. Such systems will support more effective delivery of many image-guided procedures: biopsy, minimally invasive surgery, and radiation therapy, among others. To understand the extensive role of imaging in the therapeutic process, and to appreciate the current usage of images before, during, and after treatment, we will focus our talk on four main components of image-guided therapy (IGT)and image guided surgery (IGS): localization, targeting, monitoring and control. Specifically, we will describe robust algorithms for 1. segmentation automated methods that create patient-specific models of relevant anatomy from multi-modal imagery. 2. registration automated methods that align multiple data sets with each other and with the patient. All of the methods will be illustrated from medical imagery from various modalities including MRI, CT, PET, and ultrasound.

9:00-10:00 *Room*: 126 Invited Talk

Karl Kunisch (University of Graz),
From Viscoelastic Fluids to Constrained Optimal Control
To solve large scale optimal control problems governed by partial differential equations, efficient quantitative and numerical techniques are required. This is the case, for example, for thermal control of viscoelastic fluids. We present our numerical results on this optimal control problem, which is governed by a set of partial differential equations of formidable size. The success for the practical realization of such optimal control problem relies on the succinct use of control-theoretic structure as well as on efficient numerical techniques. We shall highlight the receding horizon technique as an example for the former and semi-smooth Newton methods as an example for the latter. *Receding horizon control* is well-known for suboptimal control of ordinary differential equations. Its investigation for optimal control of infinite dimensional systems has only recently been initiated. We propose a receding horizon technique for a class of control-dissipative systems, which is applicable, for instance, to the Navier-Stokes equations. The technique will be justified by means of the system stabilization property. The construction is based on a proper choice of control Liapunov functions. We shall also address the numerical treatment of control and state constraints. While simple in structure they introduce non-differentiabilty into the optimal control formulation and cause the solution to suffer a loss of regularity. These features significantly influence numerical algorithms. We propose the *primal-dual active set strategy* as an efficient technique to incorporate constraints in optimal control problems. We further establish their relationship to *semi-smooth Newton methods* and analyze local as well as global convergence properties.

Morning:

Room: 102, Session: FA1
Chair: Reinhard Laubenbacher
Title: **Genetic Networks**

10:30-11:00 **Biochemistry by Numbers: Modeling, Signaling and Genetic Networks**,
Pedro Mendes,
Alberto de la Fuente, Paul Brazhnik, Stefan Hoops (Virginia Tech)
Genomics has revolutionized research in biological sciences. We have gone from a single-molecule approach to global views of the entire cellular machinery (e.g. with microarrays). The availability of large data sets creates an opportunity to model biochemical networks using a top-down approach, instead of the traditional bottom-up. We describe the two approaches, their pros and cons, and the strategies that we are developing to approach this exciting problem.

11:00-11:30 **Designer Gene Networks**,
Mads Kaern, James J. Collins
(Boston University)
Many fundamental cellular processes are governed by genetic programs which employ protein-DNA interactions in regulating function. Owing to recent tech-

nological advances, it is now possible to design synthetic gene regulatory networks, and the stage is set for the notion of engineered cellular control at the DNA level. Theoretically, the biochemistry of the feedback loops associated with protein-DNA interactions often leads to nonlinear equations, and the tools of nonlinear analysis become invaluable. In this talk, we describe how techniques from nonlinear dynamics and molecular biology can be utilized to model, design and construct synthetic gene regulatory networks. We present examples in which we integrate the development of a theoretical model with the construction of an experimental system. We also discuss the implications of synthetic gene regulatory networks for gene therapy, biotechnology, biocomputing and nanotechnology.

11:30-12:00 **Function, Design, and Gene Circuitry**,
Michael A. Savageau (University of Michigan)
Mathematically Controlled Comparisons have proved useful for the elucidation of biological function and design. This method will be used to characterize alternative patterns for the coupling of expression in gene circuits as well as the switching times of inducible gene circuits. Finally, I will show how the analysis of gene circuits can be used to direct construction of a gene circuit that will produce a circadian clock in the bacterium Escherichia coli.

12:00-12:30 **Comparative analysis of mathematical models of intracellular networks**,
Vassily Hatzimanikatis, Amit Mehra, Michael Beste (Northwestern University)
Intracellular networks, such as mRNA and protein expression networks, signal transduction networks, and metabolic networks, are complex systems that involve large number of components and nonlinear interactions. Mathematical modeling and analysis has been invaluable in analyzing, understanding, and redesigning intracellular networks. There is a number of alternative mathematical representations associated with every intracellular network. However, the alternative representations of a given network are not equivalent with respect to their ability to capture the properties of the network. We will compare alternative mathematical representations of protein expression networks with respect to their differences and similarities in capturing dynamic and steady state responses to environmental and genetic perturbations.

Room: 126, Session: FA2

Chair: Belinda King, Kirsten Morris
Title: **Distributed Parameter Systems: Stabilization and Control, Part II**

10:30-10:50 **An Example of Output Regulation for Distributed Parameter Systems with Infinite Dimensional Exosystem**,
David Gilliam (Texas Tech University), Christopher I. Byrnes (Washington University, St. Louis), Jeff B. Hood,(North Carolina State University) Victor I. Shubov (Texas Tech University)
In this short paper we present an example of the geometric theory of output regulation applied to solve a tracking problem for a plant consisting of a boundary controlled distributed parameter system (heat equation on a rectangle) with unbounded input and output maps and signal to be tracked generated by an infinite dimensional exosystem. The exosystem is neutrally stable but with an infinite (unbounded) set of eigenvalues distributed along the imaginary axis. For this reason the standard methods of analysis do not apply.

10:50-11:10 **Control of Systems with Infinitely Many Unstable Modes and Strongly Stabilizing Controllers Achieving a Desired Sensitivity**,
Suat Gümüşsoy, Hitay Özbay (The Ohio State University)
In this paper we consider a class of linear time invariant systems with infinitely many unstable modes. By using the parameterization of all stabilizing controllers, we show that H-infinity controllers for such systems can be computed using the techniques developed earlier for infinite dimensional plants with finitely many unstable modes. We illustrate connections between the problem solved here and an indirect method for strongly stabilizing H-infinity controller design for systems with time delays.

11:10-11:30 **Receding Horizon Control and Reduced-Order Methods**,
Ito Kazufumi (North Carolina State University)
No Abstract

11:30-11:50 **Some Problems of Control for Nonlinear Partial Differential Equations**,
David Russell (Virginia Tech)
We intend in this talk to explore several problems in control of nonlinear partial differential equations, foremost among which will be the problem of controlling the transverse buckling modes of a nonlinear elastic strip moving at constant velocity between two sets of clamping rollers. Control is exercised by rotation of

one of the roller assemblies.

11:50-12:10 **Global Stabilization of Systems of Partial Differential Equations Using Finite Dimensional Controllers**,
Igor Mezic (UCSB)
No Abstract

12:10-12:30 **Ouput Regulation of Nonlinear Systems with State Delay**,
Emilia Fridman (Tel Aviv University)
Regulator equations are derived, which generalize Francis-Byrnes-Isidori equations to the case of retarded type nonlinear systems. It is shown that, under standard assumptions,the regulator problem is solvable if and only if these equations are solvable. In the linear case, the solution of these equations is reduced to linear matrix equations. An example of a delayed Van der Pol equation illustrates the efficiency of the results.

Room: 129, Session: FA3

Chair: Wolfgang Kliemann
Title: **Stochastic Control and Estimation**

10:30-10:50 **Algebraic Optimization Techniques for the Estimation of Zero-Beta Pricing Models**,
Bernard Hanzon (Free University Amsterdam)
In the area of quantitative financial modelling the Capital Asset Pricing Model (CAPM) and the Arbitrage Pricing Theory (APT) play a prominent role. In one subclass, the so-called zero-beta pricing models, the least-squares and maximum likelihood estimation problem lead to a non-linear optimization problem. Classically the non-linearity is handled by using an iterative algorithm that tries to find the optimum, however there are apparently no guarantees that the global optimum is found in this way. Here we present an algebraic solution of the problem which guarantees that the global optimum is found.

10:50-11:10 **Trajectory Planning Under a Stochastic Uncertainty**,
Ulf Jönsson (KTH),
Clyde Martin (Texas Tech University),
Yishao Zhou (Stockholm University)
A trajectory planning problem for linear stochastic differential equations is considered in this paper. The aim is to control the system such that the expected value of the output interpolates given points at given times while the variance and an integral cost of the control effort are minimized. The solution is obtained by using the dynamic programming technique, which allows for several possible generalizations that are also considered.

11:10-11:30 **An Addendum to the Problem of Stochastic Observability**,
Vasile Dragan, Teodor Morozan
(Romanian Academy, Bucharest)
In this paper the problem of stochastic observability for a class of linear stochastic systems subject to multiplicative white noise and Markovian jumping is investigated. Necessary and sufficient conditions which guarantee the stochastic observability are given. Several examples are provided to show that stochastic observability does not implies always, stochastic detectability.

11:30-11:50 **Combined Optimization of Portfolio and Risk Exposure of an Insurance Company**,
Daniel Cajueiro, Takashi Yoneyama
(Instituto Tecnologico De Aeronautica)
This paper presents a model for an insurance company that controls its risk and is allowed to invest in a financial market with just two assets - a risk free asset and a stock. The new feature of this paper is to consider that the potential profit of this company depends on the dynamical state of the economy. The aim is to maximize the reserve of an insurance company whose manager is risk averse.

11:50-12:10 **On a Unitary Model for Two-Time Parameter Stationary Processes**,
Dan Emanuel Popovici
(University of the West Timisoara)
The basic problem in prediction theory is to estimate a certain, desired, behavior of the phenomenon under study (in our case a stationary process) using the information already obtained about it. In order to accomplish this we should separate completely the deterministic part from the part corrupted by noises. This is done via a Wold-type decomposition. In the case of a two-time parameter stationary process we characterize its different parts in some certain Wold-type decompositions in terms of a unitary model given by Berger, Coburn and Lebow for the commuting isometric pair associated to the process.

Room: 138, Session: FA4

Chair: Patrick Dewilde
Title: **Stability and Numerics**

10:30-10:50 **Parameter Dependent Extremal Norms for Linear Parameter Varying Systems**,

Fabian Wirth (University of Bremen)
We study families of parameter varying linear systems with restrictions on the derivative of the parameter variation. A method to construct exact parameterized Lyapunov norms for a wide class of such systems is presented. This may be used to derive (locally Lipschitz) continuous dependence of the exponential growth rate on the systems data. Furthermore, the maximal exponential growth rate may be approximated using only periodic parameter variations.

10:50-11:10 **On the Sensitivity of Algebraic Riccati Equations**,
Ji-guang Sun (Umea University)
Consider the continuous-time algebraic Riccati equation (CARE) and the discrete-time algebraic Riccati equation (DARE) which arise in linear control and system theory. Appropriate assumptions on the coefficient matrices guarantee the existence and uniqueness of symmetric positive semidefinite stabilizing solutions. In this paper, we apply the theory of condition developed by Rice to define condition numbers of the CARE and DARE in the Frobenius norm, and derive explicit expressions of the condition numbers in a uniform manner.

11:10-11:30 **A Numerically Reliable Method for a Neglected but Unsolved Problem: State Feedback Decoupling with Stability for (A, B, C, D) Quadruples**,
Delin Chu (National University of Singapore)
The noninteracting control problem with stability for (A, B, C, D) quadruples has been studied for a long time. But, there are no numerically verifiable solvability conditions and no numerically implementable methods for solving it in the existing literatures. Hence, indeed it is still an unsolved problem from theoretical and numerical points of view. In this talk, we develop a numerically reliable method for solving this unsolved problem. The main tool that we use is numerical linear algebra technique.

11:30-11:50 **Large Stability Property of Solutions of Large-Scale Discrete-Time Systems**,
Tanya Lukyanova, Anatoliy Martynyuk
(National Academy of Sciences of Ukraine)
The aim of this paper is to present one approach to solution of stability problem for discrete-time system based on hierarchical Lyapunov function. The example showing the proposed approach efficiency are given.

11:50-12:10 **Pole Placement Under Output Feedback: A Simplification of the Problem**,
Michael Schilmoeller, Joyce O'Halloran
(Portland State University)
For a given system defined by the matrix triple (A,B,C), which polynomials are characteristic polynomials of A+BKC as K varies? When is this set of polynomials dense in the space of all monic polynomials of degree n? We show that a polynomial occurs as a characteristic polynomial of A+BKC for some matrix K if and only if it occurs as a characteristic polynomial of A'+B'K'C' for some matrix K', where (A',B',C') is related to (A,B,C) via an equivalence relation. Regarding the question of the density of the set of characteristic polynomials, our approach allows previously known necessary (and generically sufficient) conditions to be rewritten in terms of the following two conditions on the matrices B and C: (rank B)(rank C) ¿= n and CB is not the zero matrix.

12:10-12:30 **To the Problem of Construction of Liapunov Functions for Continuous Large Scale Systems**,
Vitaliy Slyn'ko, Anatoliy Martynyuk
(National Academy of Sciences of Ukraine)
No Abstract

Room: 208, Session: FA5

Chair: Harry Trentelman
Title: **A Behavioral Approach to Systems, Control and Coding Theory**

10:30-10:50 **A Behavioral Approach to List Decoding**,
Jan Willem Polderman (University of Twente)
Margreta Kuijper (The University of Melbourne)
List decoding may be translated into a bivariate interpolationproblem. The interpolation problem is to find a bivariate polynomial of minimal weighted degree that interpolates a given set of pairs taken from a finite field. We present a behavioral approach to this interpolation problem. With the data points we associate a set of trajectories. For this set of trajectories we construct the Most Powerful Unfalsified Model. The bivariate polynomial is then derived from a specific representation of the MPUM.

10:55-11:15 **Linear Hamiltonian systems**,
Paolo Rapisarda (University of Maastricht),
H.L. Trentelman (University of Groningen)
We study linear Hamiltonian systems using bilinear and quadratic differential forms. Such a representation-free approach allows to use the same concepts and techniques to deal with systems isolated

from their environment and with systems subject to external influences, and allows to study systems described by higher-order differential equations, thus dispensing with the usual point of view in classical mechanics of considering first and second-order differential equations only.

11:20-11:40 **Approximate Time-Controllability versus Time-Controllability**,
Amol Sasane (University of Twente),
M.K. Çamlibel (University of Groningen)
This paper studies the notions of approximate time-controllability and (exact) time-controllability of behaviours. In the 1-D case, we show that these two notions are equivalent and in the n-D case we give an example of a behaviour which is approximately time-controllable, but not time-controllable. Finally, we discuss time-controllability of the heat equation. It turns out that it is time-controllable with respect to the so-called Gevrey class of second order.

11:45-12:05 **On a Class of Time-Varying Behaviors**,
Madhu Belur (University of Groningen),
M.K. Çamlibel (University of Groningen),
A.J. Sasane (University of Twente),
J.C. Willems (University of Leuven)
We study a class of time-varying systems that we encounter when we look into decomposition of behaviors. This class is the set of behaviors that are themselves polynomials in time, with coefficients as time-invariant behaviors. Operators that have such behaviors as their kernels are studied. We are led to the study of skew polynomial ring as the underlying ring for such operators.

12:10-12:30 **Synthesis of Strictly Dissipative Systems and the Strictly Suboptimal State Space H-infinity Control Problem**,
Harry. L. Trentelman (University of Groningen)
In this short paper we study the problem of existence of a controlled behavior that is strictly dissipative with respect to a quadratic supply rate. The relation between strictness and the rank of a suitable qudratic differential form that couples the dissipativity properties of the hidden behavior and the orthogonal complement of the plant behavior is analyzed.

Room: 209, Session: FA6

Chair: Naomi Leonard
Title: **Coordinated Control of Vehicle Networks**

10:30-10:50 **Stability of Systems of Self-Driven Particles Undergoing Phase Transitions**,
A. Stephen Morse (Yale University)
No Abstract

10:50-11:10 **Stability Properties of Interconnected Vehicles**,
Vijay Kumar, Herbert Tanner, George Pappas (University of Pennsylvania)
The paper presents a methodology for analyzing the stability of formations of interconnected vehicles that are based on leader-follower relations. The methodology exploits input-to-state stability properties of basic leader-follower interconnections and builds on the propagation of these properties throughout the network to establish global stability bounds. This is formalized using the notion of *(formation ISS)*, a weaker form of stability than string or mesh stability, which relates leader input(s) to formation state errors. In this paper we focus on cyclic interconnections of vehicles and show how the ISS framework can be extended to include these structures. This is the first such result for cyclic graphs that represent formations based on leader-follower controllers.

11:10-11:30 **Formations with a Mission: Stable Coordination of Vehicle Group Maneuvers**,
Naomi Leonard (Princeton University),
Petter Ögren (KTH),
Edward Fiorelli (Princeton University)
We present a stable coordination strategy for vehicle formation missions that involve group translation, rotation and expansion. The underlying coordination framework uses artificial potentials and virtual leaders. Symmetry in the is exploited to partially decouple the mission control problem into a formation management subproblem and a maneuver management subproblem. The coordination strategy is illustrated in the context of adaptive gradient climbing missions.

11:30-11:50 **Coordinated Control Strategies for Networked Vehicles: An Application to Autonomous Underwater Vehicles**,
Joao Sousa, Fernando Pereira (Universidade do Porto)
The specification and design of coordinated control strategies for networked vehicles and systems is discussed. A strategy to find the local minimum of an oceanographic scalar field with networked autonomous underwater vehicles (AUV) is presented. The strategy consists in coordinating the motions of the AUVs to implement a modified version of the simplex optimization algorithm. In the original algorithm, the scalar field is given by a function. In the modified version, the scalar field is given by the phe-

nomenon itself. The AUVs sample the phenomenon to calculate the directions of descent, and to minimize the phenomenon along each direction of descent. The strategy is discussed in the more general context of coordination and control of networked vehicles and systems.

11:50-12:10 **Group Shape Feedback Control**,
Raffaello D'Andrea (Cornell University)
In this talk we present a method for controlling the shape of a group of vehicles based on absolute and relative measurements. The control objective is a user adjustable combination of the shape of the group and the absolute position of the group. The techniques are applied to a group of sixteen mobile robots in the Cornell Autonomous Vehicles Laboratory.

12:10-12:30 **Hamiltonian Structures for Interacting Satellites**,
P.S. Krishnaprasad (University of Maryland)
No Abstract

Room: 210, Session: FA7
Chair: Mrdjan Jankovic
Title: **Nonlinear Control and Applications**

10:30-11:00 **Application of Nonlinear Lyapunov-based Controllers and Observers to Gasoline Direct Injection Engine Charge and Torque Control**,
Ilya Kolmanovsky (Ford Research Laboratory)
The paper discusses several Lyapunov-based controller and observer techniques that enhance the conventional Speed-Gradient control design approach. Our developments cover the treatment of the derivative action, time-delays, backstepping via dynamic surface control, and feedforward governor to satisfy pointwise-in-time constraints. Some of these enhancements have been already proposed in the prior literature in the context of specific automotive applications but are generalized here; other developments such as a feedforward governor are new. We also review several concrete applications of these techniques to control of gasoline direct injection engines, including torque, air-to-fuel ratio and charge control.

11:00-11:30 **Multivariable Extremum Seeking Feedback: Analysis and Design**,
Kartik B. Ariyur, Miroslav Krstic
(University of California, San Diego)
The paper provides a multivariable extremum seeking scheme, the first for systems with general time-varying parameters. We derive a stability test in a simple SISO format and develop a systematic design algorithm based on standard LTI control techniques to satisfy the stability test. We also supply an analytical quantification of the level of design difficulty in terms of the number of parameters and in terms of the shape of the unknown equilibrium map. Moreover, we remove the requirement of slow forcing for plants with strictly proper output dynamics (and consequent slow convergence) present in earlier works.

11:30-12:00 **Stabilization of Sets Parametrized by a Single Variable: Application to Ship Maneuvering**,
Roger Skjetne
(Norwegian University of Science and Technology),
Andrew R. Teel, Petar V. Kokotovic
(University of California, Santa Barbara)
We consider the problem of stabilizing sets parametrized by a single variable. Using the solution to the maneuvering problem, the state of the system is driven to a path that coincides with the set, where the particular location on the path is determined dynamically. Attractivity is obtained, and within the control structure, we induce a separation of time scales that allows us to achieve near forward invariance of the path from a large range of initial conditions.

12:00-12:30 **Nonlinear Control and Automotive Engine Applications**,
Mrdjan Jankovic (Ford Research Laboratory
Nonlinear control theory has undergone a rapid development in the past decade. Some of these results and ideas have found application in automotive powertrain control. In this paper, we illustrate a particular application where the disturbance decoupling paradigm is used to design a controller that coordinates the electronic throttle and variable cam timing actuators to achieve a desired transient engine performance. Some aspects of this problem relevant to practical application are also discussed in the paper.

Middle:

Room: 102, Session: FM1
Chair: Martin Haenggi
Title: **Mathematical Theory of Networks and Circuits**

14:00-14:20 **On Switched Hamiltonian Systems**,
Arjan van der Schaft (University of Twente),
Maurice Heemels, Karin Gerritsen
(Eindhoven University of Technology)
In this paper we study the well-posedness and stability

of a class of switched linear passive systems. Instrumental in our approach is the result, also of interest in its own right, that any passive linear system with positive definite storage function can be represented as a port-Hamiltonian system.

14:20-14:40 **Parameter Influence on the Zeros of Network Determinants**,
Sven Feldmann (University of Kaiserslautern)
No Abstract

14:40-15:00 **Canonical Realizations of Linear Time-Varying Systems**,
Fred Neerhoff, P. van der Kloet
(Delft University of Technology)
In this article, general scalar linear time-varying systems are addressed. In particular, canonical realizations with integrators, multipliers and adders are presented. Essentially, it is shown that the well-known configurations for constant systems can be generalized to the time-varying context by replacing the conventional eigenvalues by the earlier introduced dynamic eigenvalues. However, it is also shown that at least one configuration is not suitable for such a generalization.

15:00-15:20 **In Search of Sensitivity in Network Optimization**,
Mike Chen, Charuhas Pandit, Sean Meyn
We consider the average-cost optimization problem for a family of stochastic fluid models with Gaussian statistics. It is shown that optimal switching curves scale linearly, while second order sensitivity vanishes as network variability increases. Under general conditions, the switching curve is approximately affine, and in this case an affine policy obtained from consideration of the deterministic fluid model is approximately optimal.

15:20-15:40 **Dynamic Eigenvalues for Scalar Linear Time-Varying Systems**,
Pieter Van der Kloet, F.L. Neerhoff
(Delft University of Technology)
In this paper, an algorithm is derived for computing the earlier introduced eigenvalues of scalar varying systems. These new types of eigenvalues are key quantities for describing the dynamic behavior of such systems. They generalize the conventional antipodes pertaining to constant systems. Essentially, the algorithm performs successive Riccati transformations that gradually triangularize the accompanying time-varying system matrix.

15:40-16:00 **Interconnection Structures in Physical Systems: a Mathematical Formulation**,
Goran Golo, Orest V. Iftime, Arjan van der Schaft
(University of Twente)
The power-conserving structure of a physical system is known as interconnection structure. This paper presents a mathematical formulation of the interconnection structure in Hilbert spaces. Some properties of interconnection structures are pointed out and their three natural representations are treated. The developed theory is illustrated on two examples: electrical circuit and one-dimensional transmission line.

Room: 126, Session: FM2

Chair: Belinda King, Kirsten Morris
Title: **Distributed Parameter Systems: Applications and Computation, Part I**

14:00-14:30 **Performance Enhancement of Controlled Diffusion Processes by Moving Actuators**,
Michael Demetriou, Nikolaos Kazantzis
(Worcester Polytechnic Institute)
The present research work deals with the systematic development and implementation of a practical algorithm for an actuator activation and control policy through a scheme of moving actuators for systems governed by parabolic partial differential equations (PDEs). An illustrative example with simulation results of an 1-D diffusion process is included to support the paper's theoretical findings.

14:30-15:00 **Equilibrium Profiles of Tubular Reactor Nonlinear Models**,
M. Laabissi, M. E. Achhab
(Université Chouaib Doukkali),
Joseph Winkin (University of Namur (FUNDP)),
D. Dochain (Université Catholique de Louvain)
The multiplicity of the equilibrium profiles is analyzed for axial dispersion nonisothermal tubular reactors described by Arrhenius type nonlinear models. It is reported that there is at least one steady state among the physically feasible states for such models. Moreover physically meaningful conditions which ensure the multiplicity of equilibrium profiles are given.

15:00-15:30 **Control of Electronic Material**,
Katherine Kime (University of Nebraska at Kearney)
This talk will consider efforts to control solid-state structures at the quantum level. Such structures are described by the Schrodinger equation and control is exercised by a time-dependent potential term. A basic type of potential is a modulated barrier, and one

physical example of control via such a barrier arises in quantum cellular automata. We will discuss schemes for numerical approximation and also recent work in quantum feedback.

15:30-16:00 **Active Sound Field Attenuation via Acoustic Arrays**,
H.T. Banks
No Abstract

Room: 129, Session: FM3
Chair: William Helton
Title: **Operator Theoretic Methods**

14:00-14:20 **A Nehari Theorem for Continuous-Time FIR Systems**,
Gjerrit Meinsma (University of Twente), Leonid Mirkin (Technion), Zhong (Imperial College, London)
Explicit formulae are derived for Nehari extensions of continuous time FIR systems

14:25-14:45 **Optimal Approximation of Linear Operators: a Singular Value Decomposition Approach**,
Siep Weiland (Eindhoven University of Technology), Hardy Siahaan (Eindhoven University of Technology), Anton Stoorvogel (Delft University of Technology)
We present generalization of singular values and singular value decompositions to operators defined on spaces equipped with the p-norm, where p is arbitrary. The problem of optimal rank approximation of linear operators is investigated in this context. We give sufficient conditions for the existence of optimal rank approximants in the p-induced norm and discuss an application of general-ized singular values for the identification of dynamical systems from data.

14:50-15:10 **Geometrical and Spectral Properties of the Time-Varying Riccati Difference Equation**,
Nevio Carpanese (University of Padova)
Operator theoretic methods are used to study time-varying systems. The focus is on the spectral properties in order to give a geometrical parameterization of square summable symmetric solutions of time-varying Riccati difference equations.

15:15-15:35 **A Generalization of the Widrow's Quantization Theorem**,
Alexandru Isar, Dorina Isar ("Politehnica" University, Timisoara)
The Widrow's quantization theorem is analyzed. This theorem gives the conditions to be satisfied by the probability density function of a random signal for its perfect reconstruction after the quantization process. The disadvantages of this theorem (it's hypotheses are very restrictive) are envisaged and some solutions to decrease the effects of these disadvantages, in the case of different classes of input signals, used in practice, are presented.

15:40-16:00 **Functions of System and Their Perturbations**,
Alexey (Olexiy) Tikhonov (Taurida National University)
We introduce the notion of function for a conservative linear discrete-time-invariant system. We show that functions of systems naturally appear for problems related to functional models, allow an informative definition of the transfer function, have interesting applications to perturbation theory, scattering theory, and problems related to factorizations of operator-valued functions.

Room: 138, Session: FM4
Chair: David Nicholls
Title: **Nonlinear Surface Water Waves: Theory, Computation and Experiment**

14:00-14:30 **Numerical Simulation of Blow-up Solutions of the Vector Nonlinear Schrödinger Equation**,
Catherine Sulem (University of Toronto)
We present numerical simulations of blow-up solutions of the Vector Nonlinear Schrödinger equation, which arises as the subsonic limit of the vectorial Zakharov system. In the course of our calculations, we observed the phenomenon of splitting of the solution profile. To capture the structure of the solution, we developed a dynamic mesh refinement method based on a iterative grid distribution method introduced by Ren and Wang (J. Comput. Phys., 159(2000), 246)

14:30-15:00 **Existence Theory for Traveling Water Waves in Three Dimensions**,
Walter Craig (McMaster University)
This talk describes the recent results of W. Craig and D. Nicholls on the existence of traveling capilary-gravity water waves in three dimensions. This is a bifurcation problem, with parameters the two dimensional phase velocity of the solutions, and the result in the nonresonant case is a construction of two-dimensional bifurcation surfaces of solutions. In resonant cases there is a higher multiplicity of solutions, and the proof in this case is related to the reso-

nant Lyapunov center theorm of A. Weinstein and J. Moser.

15:00-15:30 **Numerical Simulation of Traveling Water Waves**,
David Nicholls (University of Notre Dame)
The author will discuss numerical methods for the simulation of two and three dimensional traveling gravity water waves, and present results on observable wave-forms and their stability. If time permits a discussion of numerical stability issues in these calculations will also be presented.

15:30-16:00 **Similarities between the Quasi-Bubble and the Generalized Wave Continuity Equation Solutions to the Shallow Water Equations**,
John H. Atkinson, Joannes Westerink
(University of Notre Dame)
The author will discuss numerical methods for the simulation of two and three dimensional traveling gravity water waves, and present results on observable wave-forms and their stability. If time permits a discussion of numerical stability issues in these calculations will also be presented.

Room: 210, Session: FM5
Chair: Lars Gruene, Fabian Wirth
Title: **Input-to-State Stability, Part II**

14:00-14:30 **Input-to-state stability of pulse width modulated control systems**,
Andrew Teel L. Moreau, D. Nesic
(University of California, Santa Barbara),
Results on stability and input-to-state stability in pulse-width modulated (PWM) control systems are presented. The results are based on a recent generalization of two time scale stability theory to differential equations with disturbances. In particular, averaging theory for systems with disturbances is used to establish the results. The nonsmooth nature of PWM systems is accommodated by working with upper semicontinuous set-valued maps, locally Lipschitz inflations of these maps, and locally Lipschitz parameterizations of locally Lipschitz set-valued maps.

14:30-15:00 **ISS for Dynamic Inputs**,
Fabian Wirth (University of Bremen)
The standard definition of ISS consists of a growth condition in terms of the size of the input and the initial condition for arbitrary measurable inputs. This property can be characterized by Lyapunov functions. If the class of inputs is restricted to the outputs of a dynamical system then some interesting new phenomena occur. We discuss charactarization of the dynamic situation with the help of Lyapunov functions and some applications.

15:00-15:30 **A Relaxation Theorem for Differential Inclusions with Applications to Stability Properties**,
Yuan Wang (Florida Atlantic Univerity),
Eduardo Sontag (Rutgers University),
Brian Ingalls (Cal Tech)
The fundamental Filippov–Ważwski Relaxation Theorem states that the solution set of an initial value problem for a locally Lipschitz inclusion is dense in the solution set of the same initial value problem for the corresponding relaxation inclusion on compact intervals. In our recent work, a complementary result was provided for inclusions with finite dimensional state spaces which says that the approximation can be carried out over non-compact or infinite intervals provided one does not insist on the same initial values. This note extends the infinite-time relaxation theorem to the inclusions whose state spaces are Banach spaces. To illustrate the motivations for studying such approximation results, we briefly discuss a quick application of the result to output stability and uniform output stability properties.

15:30-16:00 **Characterization of the Non-Uniform in Time ISS Property and Applications**,
Iasson Karafyllis, J. Tsinias
(National Technical University of Athens)
For time-varying control systems various equivalent characterizations of the non-uniform in time ISS property are established. These characterizations enable us to derive sufficient conditions for ISS concerning composite time-varying systems. One of the main results generalizes the well-known small-gain theorem due to Jiang-Teel-Praly for autonomous systems under the presence of uniform in time ISS.

Room: 126, Session: FP2
Chair: Belinda King, Ruth Curtain
Title: **Distributed Parameter Systems: Applications and Computation, Part II**

16:30-16:50 **POD Based Control of Beam Vibrations: Methodology and Experimental Implementations**,
Gregory P. Hicks, Brian Lewis
(North Carolina State University)
In this talk we discuss real time implementation of

control methodologies for the attenuation of beam vibrations in a smart structure paradigm caused by a narrow-band exogenous force. By narrow-band exogenous force we mean a periodic force over a narrow frequency band or a particular harmonic. In particular, a central part of this focus is the Proper Orthogonal Decomposition (POD) reduction technique and its application to real-time control of beam vibrations.

16:50-17:10 **A Comparison of Balancing Techniques for Reduced Order Controllers for Systems of PDEs**,
Belinda King, Katie A. E. Camp (Virginia Tech)
Reduced order controllers are often needed to achieve real time control for physical systems described by PDEs. Two methods of reduced order control design are balanced truncation and LQG balancing. Balanced truncation involves reducing the approximating finite-dimensional system and then designing a control for the low order system. LQG balancing involves controlling the full order approximating system and then reducing the control. This presentation will describe both balanced reduction methods and give numerical results.

17:10-17:30 **Modeling and Control Issues Associated with Atomic Force Microscopy**,
Ralph Smith (NCSU)
Atomic force microscopes employ cylindrical or stacked piezoceramic actuators to obtain angstrom level resolution. However, even at the low drive levels used to achieve these tolerances, the actuators exhibit hysteresis and certain constitutive nonlinearities. These effects must be accurately quantified and controlled to maintain the resolution, robustness and speed of both current instruments and future generations of devices based on this technology. In this talk, a variety of techniques for modeling hysteresis in piezoceramic materials will be discussed, and inverse compensation techniques for linear and nonlinear control design in the microscopes will be presented. Finally reduced-order models based on proper orthogonal decompositions (POD) will be employed to provide controllers which can be implemented in real time.

17:30-17:50 **The Effect on Control Design of a Stabilized Finite Element Approximation for Burgers' Equation**,
Belinda King (Virginia Tech)
The Galerkin approximation of Burgers equation is numerically unstable for small viscosity coefficients epsilon. By implementing the Galerkin Least Squares method, terms can be added stabilizing the approximation. We will use cubic splines in our approximation and will apply linear feedback control law developed for the non-stabilized problem. Our results will show that the functional gains for the non-stabilized code and the stabilized code for small viscosity coefficients epsilon will be nearly identical while the functional gains for code that use larger viscosity coefficients will vary considerably.

17:50-18:10 **Functional Gain Computations for a 1D Parabolic Equation Using Non-Uniform Meshes.**,
John Burns, Belinda B. King, Lizette Zietsman (Virginia Tech)
We consider a numerical algorithm for computing functional gains that define optimal feedback laws for Dirchlet boundary control of parabolic equations. The focus is on using non-uniform meshes to improve convergence of finite element schemes. Since boundary control problems of this type often lead to functional gains with support near the boundary, uniform meshes are not optimal. Numerical examples are presented to illustrate the effectiveness of using a non-uniform mesh concentrated near the boundary.

18:10-18:30 **A Continuous Control Design Method**,
Jeff Borggaard (ICAM, Virginia Tech)
It is clear that initial successes in challenging distributed parameter control problems will be achieved as researchers continue to exploit the underlying structure of these problems. In this talk, we look at strategies to exploit two features of these problems: the sparsity of finite element approximations and the case where the dimension of the control inputs and outputs are small, both of which make Chandrasekhar equations an effective computational tool.

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